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THE M1 ABRAMS TANK: A CASE STUDY IN MAJOR WEAPON SYSTEMS ACQUISITION AND PROGRAM MANAGEMENT

by

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June 1995

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13. ABSTRACT

The end of the Cold War has had a tremendous impact on the structure, size, and capabilities of the United States Armed Forces. The Defense buildup period of the early 1980's in which new programs flourished, is over. At a time when Defense dollars and resources are waning, both successful and unsuccessful acquisition programs must be closely scrutinized to learn how to most efficiently utilize current technology, private industry, and the existing industrial base.

One highly-successful acquisition program worthy of study and review is the United States Army's M1 Abrams Tank Program. This program's acquisition strategy was well-planned and executed, efficiently managed, and amply supported by all constituents involved in the acquisition process. This analysis of the M1 Abrams acquisition strategy has provided numerous lessons-learned that can be practically applied to future major weapon system procurements. This study concludes that program advocacy, continuous interface between the program office and the end-user community, and continuity of key program personnel are but a few of the many reasons why the M1 Abrams family of vehicles is the most lethal, survivable, and technologically advanced main battle tank in the world today.

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ABSTRACT

The end of the Cold War has had a tremendous impact on the structure, size, and capabilities of the United States Armed Forces. The Defense buildup period of the early 1980's in which new programs flourished, is over. At a time when Defense dollars and resources are waning, both successful and unsuccessful acquisition programs must be closely scrutinized to learn how to most efficiently utilize current technology, private industry, and the existing industrial base.

One highly-successful acquisition program worthy of study and review is the United States Army's M1 Abrams Tank Program. This program's acquisition strategy was well-planned and executed, efficiently managed, and amply supported by all constituents involved in the acquisition process. This analysis of the M1 Abrams acquisition strategy has provided numerous lessons-learned that can be practically applied to future major weapon system procurements. This study concludes that program advocacy, continuous interface between the program office and the end-user community, and continuity of key program personnel are but a few of the many reasons why the M1 Abrams family of vehicles is the most lethal, survivable, and technologically advanced main battle tank in the world today.

TABLE OF CONTENTS

I. INTRODUCTION

A. DISCUSSION

The end of the Cold War has had a tremendous impact on the structure, size, and capabilities of the United States Armed Forces. Both yesterday's threat and the mission of our Military Services have changed significantly, leading to the current restructuring and downsizing of the Army. The Defense buildup period of the early 1980s in which new programs flourished, is over. Modifications, pre-planned product improvements (P^3I), or complete replacement of current weapon systems with new systems is extremely costly, and each request for funding is reviewed in great detail as Congress looks to further reduce Defense spending.

Consequently, it becomes increasingly important to closely scrutinize major weapon acquisition programs to learn how most efficiently to use current technology and the existing industrial base. Hopefully, this will lead to a reduction in program costs while still meeting the needs of both the end user and the Army. One highly-successful acquisition program worthy of study and review is the United States Army's M1 Abrams Tank Program.

The M1 Abrams Tank Program began in 1972 and is still alive today, over twenty years later. Throughout its life, this program has evolved from the XM-1 prototype tank, to the M1A1, and finally into the M1A2 Block II generation tank. Over 8,100 main battle tanks have been produced by the United States since the program's inception, and many lessons-learned, teaching points, and program models have emerged over the past two decades.

B. PURPOSE

The purpose of this thesis is to examine the successful acquisition strategy of the M1 Abrams Tank System through a

comprehensive historical study of its early years of procurement, from 1971 to 1982. Emphasis will be on the researcher's interpretation of the acquisition strategy, the acquisition plan, and the historical events culminating in the successful fielding of the world's finest main battle tank. From this examination, lessons-learned will be identified that can be practically applied to future major weapon systems procurements.

C. RESEARCH SCOPE AND LIMITATIONS

This thesis is a case study of the M1 Abrams Tank System Acquisition Strategy. The study focuses on three phases of the development cycle beginning with the requirements determination phase and ending with the tank's introduction into the force. Because the acquisition process has experienced change and become more structured and formalized since the late 1970s and early 1980s, it is both relevant and necessary to examine this program in terms of current acquisition policy and procedure. Terms and acronyms that have changed will be highlighted, discussed, and cross-referenced.

This thesis covers only those aspects relating to the program's acquisition strategy and plan. Additionally, because this thesis primarily focuses on program management and not tank technology, only a general description of the M1 Abrams Tank System is covered. Classified aspects of the tank system will not be addressed.

D. RESEARCH QUESTIONS

1. The primary research question is:

What were the principal successes and failures experienced with the acquisition strategy of the M1 Abrams Tank System and can they be duplicated or avoided in future

major weapon systems acquisitions?

2. Subsidiary research questions include:

- What is a Mission Need Statement and what is involved in its development?
- What was the Mission Need Statement for the M1 Abrams Tank System?
- What is an Acquisition Strategy and how does it relate to the overall acquisition process?
- What DoD directives and policies govern the formulation of an Acquisition Strategy?
- What was the overall Acquisition Strategy for the M1?
- What is an Acquisition Plan? What are the basic requirements involved in its development and approval?
- What was the overall Acquisition Plan (including Milestones) for this program and to what extent did execution of the program meet the plan?

E. METHODOLOGY

Preliminary research included in-depth analysis of the program's case history through an extensive literature review. This included historical documentation detailing the Mission Need Statement (MNS), the Acquisition Plan, Request for Proposals (RFP), the Executive Summary, and DoD documents. A telephonic interview was also conducted with the Deputy Program Manager for the M1A2 tank program, LTC Cannon, in May 1994.

F. DEFINITIONS AND ACRONYMS

Army and Department of Defense (DoD) definitions and acronyms used in both the M1 Abrams Tank Program and in acquisition management are provided throughout the thesis where needed. Appendix A provides a consolidated list of acronyms.

II. BACKGROUND

A. INTRODUCTION

The purpose of this chapter is to establish the framework behind major weapon systems acquisition. The reader needs to have a clear understanding of the policies, politics, and purpose behind the acquisition process as a foundation for comprehensive analysis of the M1 Abrams Tank Program. Because the acquisition process has experienced change and become more structured and formalized since the late 1970s and early 1980s, it is both relevant and necessary to examine this program in terms of current acquisition policy and procedure.

This chapter provides a thorough overview on the current framework behind major weapon systems acquisition. First, this chapter highlights the principal players involved in the procurement of major weapon systems. Next, a general description of the acquisition phase and milestone review process is outlined. Finally, the Mission Need Statement (MNS), acquisition strategy and acquisition plan are defined and discussed in relation to their role in this mechanism.

B. THE MAJOR WEAPON SYSTEMS ACQUISITION PROCESS

1. Evolution

The major weapon systems acquisition process emerged from a study by the Blue Ribbon Defense Panel in 1970 and the issuance of DoD Directive 5000.1 in 1971. Further refinement came in 1976 when the Office of Management and Budget (OMB) published Circular A-109, Major Systems Acquisition. OMB Circular A-109 defines the acquisition process for major systems as,

> ...the sequence of activities starting from the agency's reconciliation of its mission needs, with its capabilities, priorities and resources, and extending through the introduction of a system into

> operational use or the otherwise successful achievement of program objectives. [Ref. 4:p. 3]

This circular requires that new programs be started only when there is an Executive agency head approval of mission needs, i.e., before competitively identifying and exploring system design concepts. [Ref. 1:p. 4]

As shown in Figure 1, both DoD Directive 5000.1 and OMB Circular A-109 attempt to forge an interface among the three decision-making support systems: requirements generation, acquisition management, and the Planning, Programming, and Budgeting System (PPBS). [Ref. 2:p. 29] It is imperative that these three support systems interface effectively for the acquisition process to function in a smooth and efficient manner.

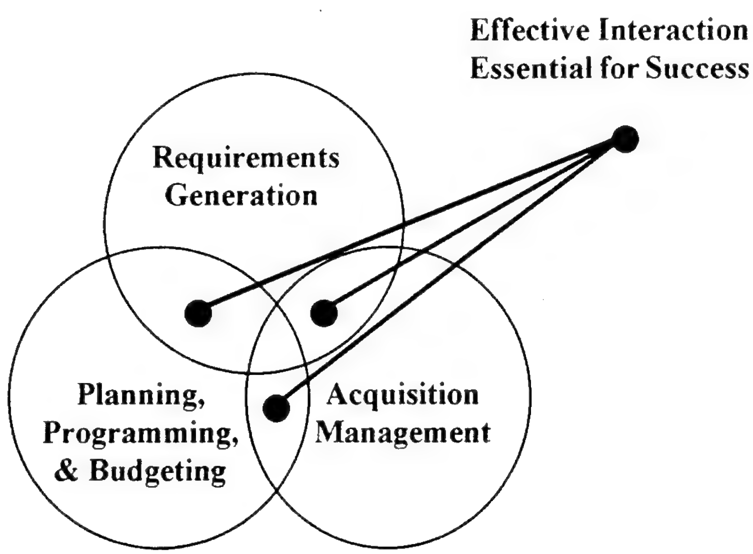

Figure 1 Three Major Decision-making Support Systems [Ref. 2:p. 29]

The two principal players in the acquisition process are the Under Secretary of Defense for Acquisition and Technology (USD(A&T)), and the Program Manager (PM). They are only two

of many important participants in this intricate, complex process but, together they form the bedrock for successful fielding of a new major weapon system. The Secretary of Defense (SECDEF) is appointed by the President of the United States to manage all military resources. The USD(A&T), subject to the authority, direction, and control of the SECDEF, serves as the Defense Acquisition Executive (DAE) for the Department of Defense. His authority and principal duties include:

- Sėrves as the Senior Procurement Executive for DoD.
- Supervises DoD acquisition.
- Chairs the Defense Acquisition Board (DAB).
- Establishes policies for acquisition to include: procurement, research and development, logistics, developmental testing, and contract management.
- Establishes policies for the maintenance of the defense industrial base of the United States.
- Prescribes policies to ensure that audit and oversight of contractor activities are coordinated and executed in a manner to prevent duplication by different elements of DoD.
- Administers the Defense Acquisition Executive Summary and Cost/Schedule Control Systems Criteria. [Ref. 3:p. 1.3.1-1&2]

All acquisition programs are placed into one of four categories. The purpose of these categories is to determine the level of milestone decision authority required for each program. In essence, this equates to final decision approval on whether or not a program will proceed to the next phase. Acquisition Category (ACAT) I programs are defined as all major programs whose procurement costs are estimated to exceed $1.8 billion (FY 1990 constant dollars) or a program whose Research, Development, Test and Evaluation (RDT&E) costs are

estimated to exceed $300 million (FY 1990 constant dollars). ACAT I programs are further subdivided into ACAT I D and I C where the difference between each is the Milestone Decision Authority (MDA). As the Defense Acquisition Executive (DAE), the USD(A&T) chairs all program and milestone decision reviews for ACAT I D major defense acquisition programs. ACAT I C programs have the Component Acquisition Executive (CAE) as the MDA. ACAT II, III, and IV programs have similar criteria but with lower dollar threshold amounts and the MDA is usually the CAE or a lower level authority. [Ref. 3:p. 1.1-1]

At the core of the major weapon systems acquisition process is the Program Manager (PM). The PM is appointed by the military system commander to be the prime manager of a major system program. The PM's role is to:

> ...exercise technical and business/financial management for the accomplishment of program objectives within approved constraints and thresholds. [Ref. 6:p. 2-1]

Although the PM receives guidance and direction from a higher authority, he alone is responsible and accountable for the success or failure of the program. In the broadest sense, the PM must manage a program within budget and schedule constraints to ensure the acquired weapon system will perform as intended and be logistically supportable when fielded to the operational user. The PM and his supporting functional specialists must continually take into account the roles, concerns, and possible actions of players in both the Executive and Legislative Branches, DoD, and Military Departments, while planning and executing a major weapon system acquisition program. [Ref. 7:p. 2-1]

First and foremost, the PM's principal function is management. This includes: planning, controlling, organizing, staffing, leading, budgeting, and monitoring. Successful PMs are often characterized as broadly-focused, multi-talented

individuals who effectively handle the personnel, financial, business, and technical management functional areas and, most importantly, are excellent communicators. [Ref. 3:p. 1.2-1]

All too frequently, the two primary managerial decision-makers previously mentioned have different perspectives when it comes to developing, producing, and fielding a new weapon system. The PM, while never losing sight of his higher authority's ultimate goal, makes every effort to field a system that meets the user-defined needs in the MNS. Often, the SECDEF or USD(A&T) are more focused on cost, performance, and political consensus. This can result in an adversarial relationship. Political 'brinkmanship' on the part of the PM is both a necessary and useful skill which must be mastered, to one degree or another, in order to survive in the Capitol Hill arena. [Ref. 3:p. 1.2-1]

2. Phases and Milestone Reviews

Providing operational military forces the weapon system resources needed to accomplish DoD objectives is the lifeblood of the major weapon systems acquisition process. The SECDEF, assisted by the Defense Acquisition Board (DAB), guides and controls the major system acquisition process by a sequence of program activity phases, milestone reviews, and decision points. This process is structured in five discrete phases separated by the major milestones shown in Figure 2. The primary purpose behind this functional design is to provide both a management and decision-making forum with a foundation and structure conducive to the long-term, multi-faceted acquisition process. [Ref. 4:p. 2-1]

All acquisition programs commence with a need that results from a deficiency in current or projected capabilities, from a technological opportunity to establish new or improved capabilities, or in response to a change in national defense policy. [Ref. 7:p. 4-1] Although not a formal phase of the acquisition process, most programs begin

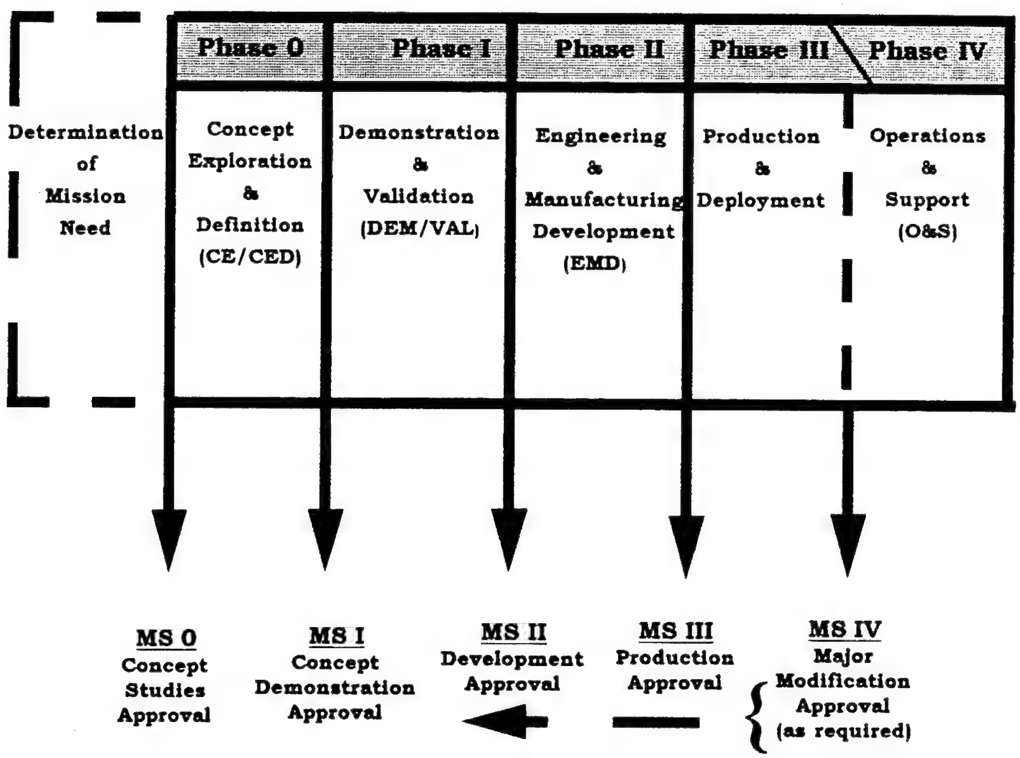

Figure 2 Acquisition Milestones and Phases
[Ref. 4:p. 2-1]

the requirements generation process with a Mission Area Analysis (MAA).

> This analysis uncovers "warfighting deficiencies"; i.e., limitations or inabilities of the Services to perform one or more of their various broad missions; technological opportunities to perform their missions better; or potential cost reductions. [Ref. 3:p. 1.1-2]

The requirements generation cycle begins with an operational requirement stated in very broad, nonspecific terms. Once an operational requirement is identified, studies of potential non-material or material alternatives are conducted which can rectify and correct this deficiency in our existing capability. The Mission Need Statement (MNS) is generated from this inadequacy in an existing capability and, for the Army, is produced by combat developers in the DoD Component branch school such as the armor, infantry, or field artillery schools.

DoD Directive 5000.2 establishes the general policies and procedures for managing major and non-major defense acquisition programs. As shown in Figure 2, milestone decisions proceed every phase and result in the decision authority's approval to either advance into the next phase or not to proceed. Exit criteria are established at the beginning of each phase and must successfully be accomplished by the milestone review before the next program phase can commence. An arduous, time-consuming process, each phase can last anywhere from six months to several years, depending on the complexity of the system being purchased.

Milestone 0, Concept Studies Approval, represents the first integration between the requirements generation and acquisition management systems. At this milestone decision point, the MDA determines if the draft MNS warrants a study of alternative concepts that can possibly satisfy the identified mission need. Nonmaterial solutions such as a change in tactics, training, organizational structure, or doctrine, are analyzed to determine if they can rectify this operational deficiency. If nonmaterial solutions are ruled out, a material need is documented in the MNS. A successful Milestone 0 review will result in entry into Phase 0, the Concept Exploration and Definition phase (CE/D). [Ref. 3:p. 1.1-2]

Phase 0, CE/D, is designed to identify and investigate alternative system design concepts that will satisfy the mission need. Studies by the Government and/or industry are conducted and system concepts are defined and selected for further development. A Cost and Operational Effectiveness Analysis (COEA) is conducted for each alternative concept and is used to judge the viability and risk areas associated with each alternative. Schedule, performance, and design trade-off opportunities are explored and the most promising alternatives are chosen. At the conclusion of this phase, the study director recommends one or more of the alternative design concepts be carried forward. An initial acquisition strategy covering development through fielding is formulated, as well as an initial Acquisition Program Baseline (APB) consisting of key cost, schedule, and performance parameters.

Several documents are required for the Milestone I, Concept Studies Approval, review. One of the most important documents is the Operational Requirements Document (ORD). The ORD, formerly called the Required Operational Capability (ROC) document, details the performance and related operational parameters for the proposed system and it also establishes the minimum acceptable requirements. Prepared by the user, the ORD spells out what the required system capabilities, characteristics, and performance parameters will be, to include items such as range, accuracy, speed, payload, communication requirements, maintenance and logistic requirements, and personnel requirements. [Ref. 12:pp. 3-1 thru 3-3] This document is updated and revised as needed for each milestone review.

A successful Milestone I review constitutes program initiation and marks the formal designation of a PM. Here is where the acquisition management system first interfaces with the PPBS through a major program 'new start' issue paper. This issue paper is sent to the Deputy SECDEF "...to confirm

that resources are available to support the program in the Future Years Defense Program (FYDP)". [Ref. 3:p. 1.1-3] Successful concept studies and a confirmation of available resources (funding) are the two primary prerequisites for entry into the next phase. Milestone I, Concept Demonstration Approval, success signifies a validation of the requirement and authorization to proceed into Phase I, Demonstration and Validation (DEM/VAL).

The purpose of the DEM/VAL phase is to further develop, demonstrate, and validate the most promising alternative concepts. Critical design characteristics and expected capabilities of the system concept are clearly defined. Technical risk and design cost drivers are identified and design trade-offs are conducted in an ever present effort to mitigate program risks. [Ref. 3:p. 1.1-3] Competition and risk reduction are often enhanced by the introduction of competitive prototyping between two or more contractors during this phase. Comparative and developmental testing of the system and/or critical subsystems are conducted to verify performance and potential suitability of the concept to fill the mission need. Low rate initial production (LRIP) quantities, if part of the acquisition strategy, are definitized during this phase as part of the exit criteria. A favorable Milestone II, Development Approval, review will approve entry into Phase II, Engineering and Manufacturing Development (EMD).

EMD is a complex, difficult, and highly-visible phase of the program in which considerable resources and manpower are expended. [Ref. 3:p. 1.1-4] The purpose of this phase is to:

- Translate the most promising design approach developed in Phase I into a stable, producible, and cost effective system design.

- Validate the manufacturing or production process.

- Demonstrate through testing that the system capabilities meet contract specification requirements, satisfy the mission need, and meet minimum acceptable operation performance requirements. [Ref. 5:p.3-21]

The predominant emphasis in EMD is on design, test, and production readiness activities. LRIP quantities are produced, providing a means to validate the production process while, simultaneously, supplying the required number of production-representative articles for Initial Operational Test and Evaluation (IOT&E). Successful Milestone III, Production Approval, allows entry into the next phase, Production and Deployment.

Phase III, Production and Deployment, is one of the most difficult challenges the PM will face next to software design/management. The objective of this phase is to achieve a stable, efficient production base and initiate deployment of the system to the operational user in the field. Production acceptance and verification testing on production line items and Follow-on Operational Test and Evaluation (FOT&E) performance are monitored with great scrutiny. [Ref. 3:p. 1.1-5] Logistics supportability and production issues will prevail. Continuous monitoring of the contractor on production performance, quality, and deficiency correction, is essential. Once the system is in the hands of the user, operational and/or support problems are identified and corrected. The overall goal of the Production and Deployment Phase is to successfully achieve an initial operational capability (IOC) and later, the full operational capability (FOC).

Milestone IV, Major Modification Approval, is required only if a major change to the system is necessary while it is still in production. If a system is out of production, a major system change is categorized as an upgrade and it would compete with other concepts in Phase 0, CE/D. [Ref. 3:p. 1.1-

5] If a major modification is approved, the MDA will determine which phase the program will be placed into based on the level of program risk, cost, testing, and other relevant factors. Usually the program is placed into Phase II, EMD.

Phase IV, Operations and Support, is the final phase in the acquisition process and, in essence, is an extension of the Production and Deployment Phase. As soon as a new system is fielded to the operational user, operational readiness must be sustained. Spare parts, modifications, maintenance, and support for new technologies are maintained to ensure the equipment's service life is extended as long as possible. The acquisition process terminates when the system is fully retired from the service.

It is important to note that not all systems follow the same exact sequence of activities. One of the key policies contained in OMB Circular A-109, is the requirement to tailor each acquisition program and continuously refine the acquisition strategy as the program advances. [Ref. 4:p. 5]

C. THE MISSION NEED STATEMENT (MNS): ITS IMPORTANCE AND RELATIONSHIP TO THE ACQUISITION PROCESS

Determination of mission need, although not a formal phase of the acquisition process, is perhaps the most important element for all potential material acquisition programs. This informal phase addresses the Service's perceived needs through an examination of nonmaterial and material solutions. As discussed earlier, when a deficiency in an existing capability cannot be overcome through a nonmaterial solution, a material solution is developed and documented in a MNS. DoD Directive 5000.1 requires the MNS to define projected needs in broad operational terms. [Ref. 8:p. 2-3] The MNS should not be written in terms of equipment or system-specific performance characteristics. It is written as a deficiency <u>not</u> as a requirement. However, it is very

important that the MNS identify the validated threat to be countered as well as the projected threat environment in which the system must operate. [Ref. 12:p. 2-1-1]

A considerable amount of forethought and planning must go into the development of this document. A poorly written MNS is open to many misinterpretations that can result in the user not obtaining the weapon system he desperately requires. Without an approved MNS, a major Defense acquisition program will never leave the drawing board.

It is important to understand how the MNS is processed for major Defense acquisition programs (ACAT I). First, the MNS goes through the Service chain for approval by the Service Chief. It is then forwarded to the Joint Requirements Oversight Council (JROC) for validation and approval. The primary function of the JROC is to review the validity of an identified mission need, assess its joint Service potential, and prioritize the importance and urgency in which this need is to be addressed. The JROC forwards their recommendation to the DAB Committee for review prior to the actual Board convening for a Milestone 0 review. Once approved by the DAB, the USD(A&T) issues an Acquisition Decision Memorandum (ADM) authorizing entry into Phase 0 CE/D. [Ref. 3:p. 1.1-2]

D. ACQUISITION STRATEGY

From the 1950s through the early 1970s the term "acquisition strategy" was used to loosely describe the overall planning for a program. Numerous studies have been conducted over the past 20 years in an attempt to define and describe acquisition strategy development and implementation. One particular study was conducted in 1976 using the combined techniques of interview and questionnaire. [Ref. 9:p. 9] Subjects ranged from PMs to staff officers in program offices to members of the civilian acquisition workforce. When asked to define "acquisition strategy", almost all interview

subjects claimed to understand the concept, but none could formulate a complete or comprehensive definition. One PM stated, "I don't get involved in that at all." [Ref. 9:p. 9] That, however, is the PM's job!

The Federal Acquisition Regulation (FAR) defines an acquisition strategy as:

> ...the program manager's overall plan for satisfying the mission need in the most effective, economical, and timely manner. [Ref. 10:p. 18,208]

An acquisition strategy can be thought of as the primary road map or blueprint on how the PM expects the program to evolve from the basic mission need to system production and equipment fielding. It is a 'living' document which is updated and revised from its inception during Phase 0 throughout the entire acquisition process.

Initially broad in scope, the acquisition strategy becomes increasingly more refined as the system nears production and deployment. It covers the entire life of the proposed system and is one of the tools utilized to reduce and mitigate risks in the program. This strategy lays the foundation for management concepts, control measures, contracting alternatives, competition, test and evaluation requirements, logistics support, personnel and training requirements, funding issues, and a host of other important factors in the acquisition program. [Ref. 3:p. 1.2-2] Because of its importance, the strategy will be tailored to meet the specific needs of the program as directed by DoD Directive 5000.2 [Ref. 5:p. 5-A-1] The acquisition strategy is a means by which the PM can evaluate and integrate the multitude of decisions he must make early on in the program life-cycle, leaving as many options as possible open for future consideration.

E. ACQUISITION PLAN

Over the past 20 years it has become increasingly more obvious that sound acquisition planning is critical to a program's success. Acquisition planning is,

> ...the process by which the efforts of all personnel responsible for an acquisition are coordinated and integrated through a comprehensive plan for fulfilling the agency need in a timely manner and at a reasonable cost. [Ref. 10:p. 16,305]

Prior to the enactment of the Competition in Contracting Act (CICA) in 1984, acquisition planning was often fragmented, haphazard, and informal. Both the acquisition plan and the planning process are now much more formalized and have statutory and regulatory requirements outlined in the FAR, Part 7. This plan documents the decisions made during the development of the acquisition strategy to include: the program's major objectives, policies, and all the definitive actions that must be accomplished during the various phases of the acquisition cycle. It integrates all of the technical, business, management, legal, and other significant actions which must be accomplished throughout the life-cycle of the program. [Ref. 10:p. 16,306]

Like the strategy, the acquisition plan is also a 'living' document and it is updated periodically; at a mininum, on an annual basis. The plan is specific with respect to near-term goals and it maps the objectives and actions required on long-term goals. The acquisition plan contains the who, what, where, when, why, and how the program will proceed from start to finish. It is an all-encompassing document that decribes the coordinated efforts of all procurement agencies participating in the program and it clearly addresses the essential elements of the procurement.

The elements of the acquisition plan are mandated in the FAR, Part 7. There are two major headings: the Background and Objectives, and the Plan of Action. The Background and Objectives section contains the following subsections:

1. Statement of Need
2. Applicable Conditions
3. Cost
    a. Acquisition Cost
    b. Life Cycle Cost
    c. Design-to-Cost
    d. Should-Cost Analysis
4. Capability or Performance
5. Delivery or Performance-period Requirements
6. Trade-offs
7. Risks
8. Acquisition Streamlining

[Ref. 11:p. xi]

The Plan of Action section contains the following subsections:

1. Sources
    a. Mandatory Sources
    b. Small and Disadvantaged Businesses
2. Competition
    a. Competitive Procedures
    b. Other than Competitive Procedures
    c. Limitations on the Use of Other than Competitive Procedures
    d. Justifications and Approvals
3. Source Selection Procedures
4. Contracting Considerations
    a. Type of Contract
    b. Special Procurement Techniques
    c. Sealed Bidding
5. Budgeting and Funding
6. Product Descriptions
    a. Restrictive Specifications
    b. Unclear or Ambiguous Specifications
7. Priorities and Allocations
8. Contractor vs. Government Performance
9. Management Information Requirements
10. Make-or-Buy
11. Test and Evaluation
12. Logistics Considerations
    a. Warranties

b. Contracting for Parts or Components
13. Government-furnished Property
14. Government-furnished Information
15. Environmental Considerations
16. Security Considerations
17. Other Considerations
18. Milestones for the Acquisition
19. Participants
[Ref. 11:pp. xi-xiii]

Individual program acquisition plans are tailored and, understandably, will vary in content from the above format. It is obvious, from the elements listed above, why the acquisition plan is all-encompassing and of such strategic importance to the success or failure of a major acquisition program.

F. SUMMARY

This chapter has provided a broad overview of the intricate and complex process of acquiring major weapon systems. The major weapon systems acquisition process is structured in five discrete phases seperated by five milestone decision points. The MNS, acquisition strategy, and acquisition plan are three critical documents required upfront and early in the acquisition process. These three documents lay the foundation and framework for the future success of any program and require careful, thorough planning in their development. All programs should be tailored to fit their own specific objectives and individual characteristics. The tailoring of a specific program is accomplished through both the acquisition strategy and the acquisition plan.

III. THE M1 ABRAMS TANK PROGRAM

A. INTRODUCTION

This chapter provides a thorough overview of the acquisition history for the M1 Abrams Tank Program. A description of the tank is also provided to include its capabilities, characteristics, and significant features. In addition, program management issues are discussed in order to lay a foundation for the acquisition strategy discussion in the subsequent chapter.

B. ACQUISITION HISTORY OF THE M1 ABRAMS TANK

1. The MBT-70/XM-803 Joint Venture

Although one of the Army's main battle tanks (MBT), the M-60, was first fielded to operational units in 1959, it was not a true, newly-designed tank but rather a tank "...hastily cobbled together from parts of two earlier tanks." [Ref. 12:p. 21] When retired General James H. Polk, commander of the U.S. Army in Europe during the late 1960's, was asked to assess this 'new' M-60 tank he said, "...the reworked tank will not be the best tank on the European battlefield by any stretch of the imagination." [Ref. 13:p. 9] This fact, coupled with the knowledge that Warsaw Pact tanks outnumbered those of NATO by a two-to-one margin, made it clear that the United States Army needed a new main battle tank to assure victory on the next battlefield. [Ref. 12:p. 14]

In 1963, only four years after the fielding of the M-60 tank had begun, both the United States and the Federal Republic of Germany (GE) entered into a formal agreement for joint development of a main battle tank, the MBT-70 (later re-designated the XM-803). [Ref. 14:p. 1] SECDEF Robert S. McNamara, was the major proponent for this joint venture because he was convinced:

> ...that by sharing ideas and costs, the allies could produce weapons that not only were better and cheaper but would be easier and less expensive to maintain than if each nation continued to go its own way. [Ref. 12:p. 25]

Unfortunately, both McNamara and the Army had differing agendas; the former was politically-motivated and the latter tactically-motivated. McNamara wanted to develop a new process for providing weapons for the alliance; the Army just wanted a new tank capable of defeating the enemy. [Ref. 12: pp. 25-26]

The foreign joint venture had very strong support but, nonetheless failed after eight years, ending in December 1971. The primary reason for the MBT-70 program failure was its high per unit cost estimate of between $850,000 to $1,000,000 (FY 1969 dollars). [Ref. 14:p. 1] By comparison, the per unit cost of the M-60 tank was much lower, between $218,000 and $333,000. The Conference Committee of the U.S. Senate and House of Representatives was "...firmly convinced that no tank is worth that much money." [Ref. 15:p. 2] After spending over $215 million on Research & Development (R&D), and eight years of intense effort, the program was terminated as unnecessarily complex, excessively sophisticated, and too expensive. [Ref. 15:p. 2]

2. Genesis of the M1 Tank System

a. The Task Force at Work

In January 1972, the United States Army established a task force headed by Major General (MG) William R. Desobry to develop a main battle tank which would improve performance and capabilities beyond those of the M-60 tank. [Ref. 12:p. 93] With a budget of $217,500 and a five month time constraint, the mission of this task force was to produce a draft Mission Need Statement (MNS), prepare and outline a development schedule, and prepare as complete a concept formulation package as possible. [Ref. 14:pp. 1&2]

The job of the task force was not to design a tank but to prepare the Army to tell the competing contractors what the tank would be expected to do. [Ref. 12:p. 94] Three critical questions had to be answered about the tank.

- How much should it weigh?
- How large a crew is needed to man it?
- What weapons should it carry?
  [Ref. 12:p. 94]

The task force debated and deliberated several weeks over these questions and conducted in-house trade-off analysis on each critical issue.

The task force received two very specific messages from both Congress and the Pentagon. Their goal was not to build the best tank in the world, but to build the best tank possible for a limited amount of money: about $500,000 per tank (FY 1972 constant dollars). [Ref. 12:p. 95] The most overriding and time-consuming issue for the task force became the question of weight.

A breakthrough in armor technology, called Chobham armor, was developed by the British and further "Americanized" by scientists in the United States during the spring of 1972. This 'new' armor, arranged in honeycomb-like baffles, contained an alloy of depleted uranium making it much stronger than conventional armor. This depleted uranium alloy had two and one-half times the density of steel without the added thickness. [Ref. 12:p. 130] Unknown at the time, this new armor would dominate design, weight, and cost of the tank for several years and it required a new and as yet unperfected method of manufacture. Additional weight had a major impact on several of the tank sub-systems including the engine, transmission, suspension, and track; all of which would have to be made more powerful and/or durable due to the added

stres. :d burden of increased weight. [Ref. 12:pp. 95-130]

A. nough the issue of weight would fluctuate for several years, the task force initially recommended a weight between 46 and 52 tons. A recommendation of four personnel to crew the vehicle was also forwarded, along with weapons consisting of a 105 millimeter (mm) main gun, a 7.62mm co-axial machine gun, a 7.62mm loaders machine gun and a .50 caliber machine gun for the tank commander. [Ref. 12:pp. 95-106] In August 1972, the task force published their concept for the new main battle tank. On 18 January 1973, the Deputy Secretary of Defense signed the Development Concept Paper (presently known as the Acquisition Decision Memorandum (ADM)) which defined the final approved program. [Ref. 17:p. 8]

The principal objective of the M1 Tank Program provided in the MNS was to field a tank system:

> ...specifically designed as an assault vehicle to replace an aging fleet and to meet the projected threat of the 1980's and beyond. [Ref. 16:p. 2]

In addition, this tank system would provide increased performance over other tanks currently in the Army inventory in the areas of reliability, availability, maintainability, survivability, tactical mobility, night fighting capability, fire-on-the-move capability, and hit probability. [Ref. 16:p. 2]

The MNS also highlighted the Army's evaluation of the shortcomings of the current M-60 tank. The M-60 tank was deemed tactically and technically incapable of defeating a numerically superior threat under day, night, adverse weather, Nuclear, Biological, and Chemical (NBC), and normal battlefield obscurant conditions. The following M-60 tank operational deficiencies existed:

- Large silhouette in both height and width; larger than any other tank in the world.

- Inadequate acceleration and cross-country speed.
- Unacceptable reliability of mobility and firepower systems.
- Lack of adequate firepower on the move.
- Insufficient ballistic protection against hyper-velocity kinetic energy munitions. [Ref. 14:p. 4]

The user wanted a tank that would be faster, more survivable, and more lethal than the M-60 tank. Early in the program it was hypothesized that the new M1 tank, in the long run, would be cheaper to operate and support in the field than the M-60 tank. Although this hypothesis was later proven to be inaccurate, the performance advantages of the M1 tank far surpassed those of the M-60 tank. [Ref. 18:p. 1]

b. Phase I: Competitive Prototype Validation

The procurement philosophy for the tank was a seven-year development program accomplished in three separate, distinct phases. Phase I of the plan was Competitive Prototype Validation, currently known as Demonstration and Validation (DEM/VAL). This phase combined both the Concept Exploration and Definition phase and the Demonstration and Validation phase of today into one succinct phase of operation. In this phase, competitive prototypes were developed and produced by two contractors, the Defense Division of Chrysler Corporation and the Detroit Allison Division of General Motors Corporation (GM). [Ref. 16:pp. 2,7] Contracts to both competitors were awarded on 28 June 1973 with prototype vehicle delivery scheduled for February 1976.

While Phase I prototype vehicles were being produced by both competitors, the Army signed a Memorandum of Understanding (MOU) with the Federal Republic of Germany in 1974 to evaluate a modified version of the West German Leopard II Tank against U.S. material need requirements. The goal was

to achieve maximum standardization of tank subsystems of both the U.S. and West German tanks by the date of introduction into their respective forces. FMC Corporation expressed an interest in representing Krauss-Maffei, the German tank producer, for U.S. production of the Leopard II Tank. After completing an extensive cost/feasibility study, FMC Corporation and the Germans agreed that the venture presented an extreme degree of high cost and risk and they withdrew from the competition. [Ref. 19:p. 6]

After extensive comparative engineering and operational testing on both prototype vehicles, the Source Selection Authority (SSA), Secretary of the Army Donald Rumsfeld, selected the Defense Division of Chrysler Corporation prototype vehicle for entry into Phase II. [Ref. 12:pp. 142-156]. But, the selection of Chrysler Corporation was not a clear-cut, easy decision to make. Both GM and Chrysler were given liberal freedom to produce a prototype tank through using Government performance specifications versus the more restrictive design specifications. [Ref. 12:p. 138] The following six mandatory requirements were placed on both contractors for Phase I:

- Tank weight not to exceed 58 tons.
- Width not to exceed 144 inches (permitting passage through tunnels in Europe).
- Remain on schedule.
- Provide significant improvements over the current M-60 tank.
- Meet Reliability, Availability, Maintainability, and Durability (RAMD) standards.
- Remain under the Design-to-Unit-Cost (DTUC) ceiling of $507,790 per tank in FY 1972 dollars. [Ref. 12:p. 140]

As long as the contractors met these six mandatory requirements, they had the freedom to make trade-offs between

other factors such as survivability, mobility, and transportability. [Ref. 12:p. 140]

Because use of the new armor technology imposed additional weight requirements, the necessity for an engine at least twice as powerful as ones currently existing, posed a critical problem for both contractors. Chrysler Corporation developed a modified helicopter turbine engine; a moderately risky, new technological invention. GM, on the other hand, developed a new variable compression diesel engine much like that which powered the M-60 tank. The advantages of the turbine engine over a diesel engine are:

- Smaller/lighter than diesel engine
- Quieter engine with a near-smokeless exhaust
- Requires no warm-up period before starting in adverse weather
- Quicker acceleration from idle to full power
- More reliable and easier/cheaper to maintain
- Comprised of one-third less internal moving parts

The disadvantages of the turbine engine are:

- Requires 'clean' air; a tough requirement to fulfill on a dirty battlefield
- Requires more fuel to operate which is a logistics and cost burden
- Requires new inventory of spare parts, new maintenance procedures, and new training for personnel
- Costs roughly $40,000 more to manufacture per engine
- Moderately risky 'new' technology
  [Ref. 12:pp. 140-145]

Both contractors produced excellent prototype vehicles; each with its own strengths and advantages. In the end, the turbine-powered Chrysler tank won primarily because their

contract proposal bid for full-scale development was $196 million; $36 million less than GM. [Ref. 12:p. 158]

c. *Phase II: Engineering Development and Producibility Engineering and Planning*

Phase II of the plan was Full Scale Engineering Development and Producibility Engineering and Planning (ED/PEP), known today as Engineering and Manufacturing Development (EMD). During this phase, Chrysler fabricated 11 XM1 pilot vehicles at the Detroit Arsenal Tank Plant (DATP), from November 1976 through March 1978. These pre-production pilot vehicles underwent extensive concurrent developmental and operational testing (DT/OT II) from March 1978 through February 1979. [Ref. 12:pp. 161-162]

Simultaneous with this activity, a second production site, the Lima Army Tank Plant (LATP) located in Lima, Ohio, was built, fully-facilitized, and labeled as the most modern and efficient tank production facility in the world. The Acquisition Plan called for the use of interdependent Government-Owned/Contractor-Operated (GOCO) facilities to produce the M1 tank. Both DATP and LATP were adopted as GOCO facilities. Unlike most conventional GOCO arrangements, Chrysler Defense had their own unique production process which they used to manufacture the M1 Tank System while the Government provided its requirements in the Technical Data Package (TDP). [Ref. 19:p. 7]

DT/OT II did not proceed without its fair share of problems. The first major problem occurred with Chrysler's engine subcontractor, Avco Lycoming. A GOCO facility in Stratford, Connecticut became Avco Lycoming's base plant in 1976. Seeing little use since World War II production of the Navy's Corsair fighters, this hanger-like plant was in deplorable condition. Lacking efficient management personnel, suitable work conditions, and modernized plant equipment, Avco Lycoming's engine production fell drastically behind schedule.

[Ref. 12:p. 160] Production and quality control problems also plagued this sole-source contractor, to the point that:

> ...under increasing pressure from the Army, Avco finally brought in new management, modernized the plant and equipment, and, belatedly, got a handle on production and quality control problems. [Ref. 12:p. 161]

During concurrent DT/OT II in 1978 and 1979, a limited number of prototype vehicles available for testing became a major problem. With no room for slippage in the already tight schedule, no shakedown-period was provided for vehicles coming directly from the factory prior to the commencement of testing. Without adequate time to identify and fix deficiencies in the pilot vehicles <u>before</u> testing began, numerous unforeseen problems developed during testing. To make matters worse, the shortage of prototype vehicles was so severe that none were on-hand back in the plant on which to replicate and solve the problems identified at the test sites. [Ref. 12:pp. 161&162]

Two other major problems surfaced during OT II. Chrysler did not provide well-written technical manuals for operator-level maintenance functions and their maintenance test equipment was poorly designed. Because the tank was brand-new and significantly different from the M-60 tank the soldiers were familiar with, the poorly-written technical manuals for normal operation and maintenance functions were virtually unusable by the soldiers. In addition, the test equipment used to identify, diagnose, and fix tank malfunctions did not isolate and detect problems properly and it was not user-friendly. [Ref. 12:p. 163]

These problems, coupled with a myriad of normal design glitches, caused great concern for all involved in the program. Engine and transmission failures were relatively high as was the occurrence of thrown tank track. Eventually

these problems were solved and "...those closest to the situation were convinced they did not have any 'program stoppers'." [Ref. 12:p. 167]

At the conclusion of DT/OT II, test score results were well above the threshold necessary for a production go-ahead. In April 1979, the Army Systems Acquisition Review Council (ASARC) and the Defense Systems Acquisition Review Council (DSARC), currently known as the DAB, recommended the XM1 for Low-Rate Initial Production (LRIP). Initially, a total quantity of 3,312 tanks was required, but in 1981 that figure was revised upward to a total production requirement of 7,058 tanks through FY 1988. [Ref. 14:p. B-10]

d. Phase III: Low-Rate Initial Production

LRIP at the Lima and Detroit Arsenal Tank Plants called for assembly of 110 vehicles. The first two production tanks were delivered at LATP for a special acceptance ceremony on 28 February 1980. At this ceremony, the new tank was unveiled and formally named in honor of the late General Creighton Abrams, Jr. [Ref. 14:p. B-9]

The LRIP vehicles underwent DT/OT III from September 1980 to May 1981. In January 1981, the XM1 achieved Initial Operational Capability (IOC). The tank was type-classified **Standard** as the M1 Abrams Tank on 17 February 1981, and full production of 60 vehicles per month (30 at LATP and 30 at DATP) was authorized on 19 November 1981. General Dynamics Land Systems (GDLS) purchased Chrysler Defense in February 1982 and assumed all contractual responsibilities with the Government for production of the tank. [Ref. 14:pp. B-6 thru B-11]

In January 1981, the M1 Abrams Tank was first fielded to units in the United States, and one year later, to units in Europe. This newly-designed tank met or exceeded all design and performance specifications and its capability improvements excited both the program personnel and the operational user.

[Ref. 14:p. C-5]

C. DESCRIPTION OF THE M1 ABRAMS TANK

As shown in Figure 3, the M1 Abrams Tank is a 60-ton, fully-integrated, four man crew, advanced technology, armored tank system. Powered by a 1,500 horsepower multi-fuel, air cooled turbine engine, this tank can reach a top speed of 45 miles per hour (mph). The turbine engine produces a 25:1 horsepower-to-ton ratio and, coupled with its automatic, six-speed transmission, can accelerate from 0 to 20 mph in 6.1 seconds. With its 500 gallon compartmentalized fuel tank, the tank has a cruising range of just over 275 miles. The Abrams tank also has a compartmentalized ammunition storage area and self-activating Halon fire extinguishers to enhance crew survivability. [Ref. 20:pp. 31-34]

Fire control for the M1 consists of a ballistic computer, laser range finder, gunner and commander sights, and a parallel-scan thermal image system. The fire control system is designed to provide a stabilized, fully-integrated, day/night sighting system capable of accurate shoot-on-the-move operation. An auxiliary 'telescope' is provided as a main gun secondary fire control device. An advanced suspension system comprised of 14 road wheel stations with steel torsion bars and intermittent rotary shock absorbers, provides the capability to deliver accurate fire-on-the-move, as well as increased speed and agility over rough terrain. [Ref. 20:pp. 31-34]

Primary armament for the system is provided by the 105mm M68 main gun. However, the turret has been designed to accept, at a later date, an upgraded 120mm main gun with only minor structural changes. (M1A1 Abrams Tank scheduled for production in late 1985) Complimentary armament consists of a .50 caliber machine gun for the tank commander and two 7.62mm machine guns, one coaxially mounted along the main gun

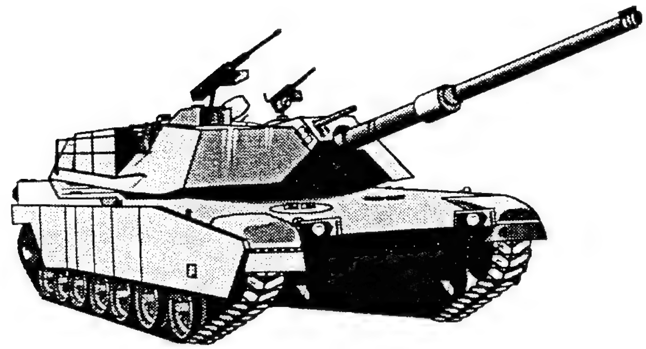

Figure 3 The M1 Abrams Tank
Source: Powerpoint Clip Art

and the other externally-mounted at the loader's station. Smoke screen generation is accomplished by the use of two externally-mounted six-tube grenade launchers and an engine-mounted smoke generation device. [Ref. 20:pp. 31-34] Appendix B provides an unclassified, consolidated list of the M1 Abrams Tank system characteristics.

D. PROGRAM MANAGEMENT OF THE M1 ABRAMS TANK

1. Appointment of the First PM

On 18 July 1972, Brigadier General (BG) Robert J. Baer was named program manager for the M1 Abrams tank. The program was of such vital importance to the Army that:

> ...he received a seven-page charter giving him a direct channel of communication to both the Chief of Staff and Secretary of the Army. [Ref. 12:p. 132]

Unlike his predecessor on the MBT-70 program, BG Baer established his headquarters in Warren, Michigan, near the Detroit Army Tank Plant in order to keep a close eye on both contractors and maintain a handle on their day-to-day activities. Although funding issues were of critical importance to the program, he organized a strong supporting staff in Washington, D.C., to interact with both the Pentagon and program allies on Capitol Hill. He compensated for the distance gap from the capitol by making frequent trips and maintaining important face-to-face communication with his superiors. The Chief of Staff of the Army, General Abrams, charged both BG Baer and the Commandant of the Armor Center, Major General (MG) Donn Starry, with total responsibility for the success of the program. BG Baer was responsible as the 'builder' and MG Starry as the representative/coordinator of the user community. [Ref. 12:pp. 132-133]

A great working relationship existed between both men. BG Baer was directed not to let the user community add costly, unnecessary "...bells and whistles..." and to keep the design simple; "....we can't afford the best of everything." [Ref. 12:p. 133] Simultaneously, MG Starry was directed to keep United States Army Europe (USAREUR): "...informed of what we're doing to make sure their input is reflected in the tank." [Ref. 12:p. 134] This close personal and working relationship was one key to the early success of the program as they both swore they were not going to let anyone drive a wedge between them. [Ref. 12:pp. 134-135]

a. *The PM's Challenge*

The first two immediate problems that BG Baer faced as the PM were to establish both cost goals and the criteria for selection of prototype contractors. A cost committee was immediately formed and their first task was to determine how to break down and establish cost. This was no simple task, considering that the committee had no idea what the tank would

look like, who would build it, and how many would be built. Complicating matters further, the tank would not begin production for at least five more years. [Ref. 12:p. 135]

Two methods of measuring cost were defined; design-to-unit-hardware-cost (DTUC) and life-cycle-cost (LCC). The DTUC figure is calculated by estimating the cost of individual components of a weapon system and adding them all together for a total, individual system cost. This method of cost breakdown includes the cost of building an individual tank and includes the cost of special tools and equipment used in the manufacturing process. Unfortunately, it does not include the funds expended on research and development (R&D) nor the inherent costs for production facilities. In simplistic terms, this cost is loosely comparable to what most people think of as the 'sticker price'. [Ref. 12:p. 136]

The LCC, on the other hand, not only covers the R&D, manufacturing, and production costs, but also the total operating costs of a system as long as it remains in service. This includes the personnel, training, maintenance, spare parts, fuel, and other logistical support costs, and even disposal costs associated with the system at the time of retirement. In essence, the LCC is the only cost figure which tells the <u>true</u> cost of a major weapon system throughout its entire life. [Ref. 12:p. 137]

Knowing that Congress would never accept a million dollar tank, BG Baer decided on using the Pentagon approved DTUC and the magic number was set at $507,790 per tank (measured in FY 1972 dollars). Estimating the best they knew how, the cost committee and BG Baer would have to live by that figure for a number of years. Almost as important, the PM knew that Congress would measure his performance and success or failure by that figure alone. This cost threshold would repeatedly haunt and almost kill the entire tank program over the ensuing years. [Ref. 12:pp. 136-137]

In the Acquisition Plan (1st Endorsement) dated March 1975, total estimated program acquisition costs from program initiation through completion of quantity production (3,312 vehicles) was $5,045 million. Figure 4 depicts estimated program costs by fiscal year (FY). Two important notes follow:

- the RDT&E costs exclude $20 million in sunk costs for FY72 initial start-up 'concept studies'.
- FY76 through completion costs are based on January 1975 inflation indices. [Ref. 16:p. 4]

($ in Millions)

	FY73	FY74	FY75	FY76	FY77	FY78	FY79	Balance to Completion	Total
RDT&E	21.5	54.0	65.0	50.2	142.6	95.2	49.9	11.5	489.9
PEMA	0	0	2.0	0	45.6	109.4	387.3	4010.8	4555.1
Total	21.5	54.0	67.0	50.2	188.2	204.6	437.2	4022.3	**5045.0**

Figure 4 1975 Estimated Program Costs
[Ref. 16:p. 4]

b. Source Selection

Selecting two manufacturers to build tank prototypes for Phase I was a congressional mandate which fit in with the then popular Fly-Before-You-Buy procurement practice. Many companies showed an interest in the tank program and 98 were present for the initial bidders' conference. Only the 'Big Three' auto-makers, Ford, Chrysler, and GM, were expected to show a serious interest. Requests for Proposals (RFP) were sent to potential contractors on 23 January 1973 and only Chrysler and GM submitted proposals. Ford, who had not manufactured tanks since WW II, gave the project serious consideration but dropped out when Israeli tank designers on

their staff could not obtain security clearances. On 28 June 1973 developmental contracts were awarded to both Chrysler and GM. [Ref. 12:pp. 138-140] Chrysler won the competitive prototype validation phase and was awarded the engineering development contract. In addition, they also were awarded the follow-on full scale production contract in 1979 on a sole-source basis. [Ref. 14:pp. B-6 thru B-8]

2. Subsequent PMs

Five years after assignment as the PM, BG(P) Donald M. Babers replaced MG Baer in June of 1977. BG(P) Babers would remain the PM through June 1980, seeing his dedication and hard labor come to fruition as the first two M1 Abrams production tanks were delivered in February 1980. Babers also played a key role in the initiation of the 120mm main gun system development and integration program for incorporation into the future M1A1 tank scheduled to begin production in FY 1985. [Ref. 14:pp. B-6 thru B-9]

MG Duard D. Ball replaced MG Babers in July 1980 and witnessed the program reach IOC in January 1981. He played an instrumental role in the SECDEF's decision to proceed with full-rate production of the M1 at a rate of 60 vehicles per month (30 each at DATP and LATP). In March 1982 the first full-scale production tanks were delivered from the DATP and by August of that same year, five Army battalions had been fielded and trained. [Ref. 14:pp. B-9 thru B-11]

The last basic M1 Abrams tank was produced in January 1985, bringing the total number manufactured to 2,374. The improved tank version, designated the IPM1, entered production in December 1984 and for over twelve months both were produced concurrently.

A total of 8,101 Abrams tanks were produced for the United States military since program inception in 1972. As of August 1993, production figures including Foreign Military

Sales (FMS) stood as follows:

M1..................	2,374
IPM1..................	894
M1A1................	4,771
M1A2..................	62
Total U.S	**8,101**
M1A1 Egypt............	550
M1A2 Saudi Arabia.....	700
M1A2 Kuwait...........	760
Total	**10,111**

[Ref. 21:p. 18-19]

E. SUMMARY

This chapter has provided a broad overview of the acquisition history for the M1 Abrams Tank Program. A description of the tank to include its significant features and characteristics has also been outlined. An overview of the major program management issues has been addressed in preparation for an in-depth review of the acquisition strategy discussed in the next chapter.

The newly-designed and developed M1 tank met or exceeded all the design and performance specifications required by the Army. It has provided increased performance in the areas of survivability, tactical mobility, night fighting capability, fire-on-the-move capability, and hit probability. Clearly, this new tank was, and still is, capable of meeting and defeating the projected threat of the 1980's and beyond.

IV. THE M1 ABRAMS TANK PROGRAM ACQUISITION STRATEGY

A. INTRODUCTION

This chapter provides an in-depth overview of the M1 Abrams program acquisition strategy. The development of a tailored acquisition strategy by the PM is both a difficult and challenging task. A multitude of requirements must be blended in order to provide a conceptual basis for the overall program plan that the PM will follow throughout program execution. The development of this strategy is one of the first tasks that must be completed at the onset of a new program and the PM is forced to make many key decisions up front and early which will have tremendous impacts throughout the program's life-cycle.

The list of strategic options for major systems acquisition is lengthy. The following strategies for the M1 Abrams tank program are addressed: competition, concurrency, design-to-cost, pre-planned product improvement (P^3I), and incentives. These strategic alternatives, although not all-inclusive, formed the foundation for success of this program.

B. M1 ABRAMS TANK ACQUISITION STRATEGY

The acquisition strategy for this program was unique from its inception. In June of 1972, the Department of the Army published the Material Acquisition Guidelines (MAG) which, among other guiding principles, established a 'standard' six-year development program for new major weapon system acquisition programs. However, the procurement philosophy for the M1 program was based on a seven-year development concept. The most significant benefit of the seven-year development program over the six-year period, was a drastic reduction in the degree of technical risk associated with achieving the required levels of armor protection within the weight limits

imposed. This new technology would take a substantial amount of time to perfect and the addition of one year to the program provided the necessary flexibility required to mitigate this inherent risk. [Ref. 22:p. 2]

1. Competition

Because of the unique, military-specific nature of the Defense sector, competition in this market is both imperfect and, for the most part, monopsonistic (only one buyer). Qualified sources are usually very limited in number and there are few sellers who can deliver a quality product at a reasonable price. Competition is one approach utilized to constrain cost growth while simultaneously capturing the technological ingenuity of private industry. Maintaining a strong and flexible defense industrial base is another consideration when discussing the merits of competition as it relates to Government procurement. [Ref. 7:p. 5-2]

The M1 Abrams tank program utilized competition during its DEM/VAL phase although qualified competitors in this exclusive market were, obviously, limited. During the EMD phase, one contractor (Chrysler Defense) was selected and awarded the sole-source prime contract. In the mid 1970s, this competitive strategy was standard practice for a developmental program of this magnitude and it is still a common practice today. Although the first rendition of the procurement strategy recommended a sole-source contract for initial **and** follow-on production, this strategy was later determined to be 'suspect' and revised to include competition for full-scale production. [Ref. 16:p. 2]

In addition to the aforementioned competitive strategy, "break-out" was also included as an option during follow-on production. Break-out is defined as the practice of selective competition whereby "...critical subsystems or components are selected for competitive production in out-year buys." [Ref. 7:p. 5-5] Usually, those components selected for breakout are

procured by the Government from industry direct and then provided to the prime contractor as Government-Furnished Equipment (GFE) or Government Furnished Material (GFM). [Ref. 23:p. B-11] The foresight of this alternative, recurrent option would prove to be very valuable throughout the program's life.

During the first two years of production, Chrysler Defense purchased and manufactured most of the components and materials necessary to fabricate and assemble the complete M1 tank. The exceptions were: the main gun, machine guns, ammunition, communications equipment, basic issue items (BII), driver's night sight, and NBC components. [Ref. 19:p. 29] Beginning with the third year of production (FY 1981), four components were selected for break-out and were provided as GFM. Two components were procured sole-source and two were competed. These four components were:

ITEM	**SOURCE**
AGT 1500 Turbine Engine	AVCO
X1100-3B Transmission	Allison Transmission Div.
Final Drive	Competitive
Track (T-158)	Competitive

[Ref. 19:pp. 20]

The Government invested in excess of $1 billion to establish interdependent production facilities and this large investment became the program's leading justification for requesting a sole-source selection for follow-on production. [Ref. 19:p. 19] The exception utilized was based on the judgement that any award to another source would result in:

> ...substantial duplication of cost to the Government that would not be expected to be recovered through competition, and introduction of another source at this time would cause an unacceptable delay in fulfilling the Army's

requirements. [Ref. 19:p. 23]

If a new source were introduced, a minimum of a two-year break in production would have occurred since it was unlikely that competitive benefits would or could support a duplication of the initial facility investment. Since General Dynamic Land System's (GDLS) purchase of Chrysler Defense in February 1982, their proven performance record has justified continued sole-source procurement to be the most beneficial to the Government in terms of cost and readiness. As late as 1990, sole-source for production was still utilized since production quality was high, deliveries were on time or ahead of schedule, and the high start-up costs for a new contractor precluded new prime contractor competition. [Ref.19:pp. 21-23]

a. *Advantages of Competition*

The advantages of competition include:

- Obtaining a lower price for a product
- Obtaining a higher quality product
- Expanding the industrial base
- Enhancing surge capacity in an emergency
- Providing more than one source for product innovation
- Stimulating research and development
- Encouraging an incumbent to be more cost-conscious
- Encourage the incumbent to be more responsive to the concerns of the buyer and to address criticisms. [Ref. 7:p. 5-3]

b. *Disadvantages of Competition*

The disadvantages of competition include:

- Increased initial cost due to duplication of the work to administer contracts, prepare to produce a product, or accomplish a specific task
- More complex and costly support of duplicate products in the field
- Variations in quality between competitive products

- Time and cost to educate second source (can delay fielding of future units)
- Weakening of any working relationship that exists between a specific contractor and the Program Office [Ref. 7:p. 5-3]

2. Concurrency

In an effort to shorten the ever-increasing acquisition cycle, concurrency is one approach utilized by PMs to shorten the time required to achieve an IOC. Concurrency is that part of an acquisition strategy where there is:

> ...an overlap of activities constituting at least part of full-scale development, transition to production, achievement of production rate, and initial deployment of the system. Concurrency can also occur through elimination of a phase or overlapping of phases in the acquisition process. [Ref. 7:p. 5-14]

Concurrency is often necessary to compress or shorten the development and testing cycle in order to meet the acquisition system's pre-planned schedule. If cost and schedule were of little concern, the normative approach would be to conduct design, test, production, and deployment sequentially, thus allowing adequate time to fix any resultant deficiencies. Unfortunately, this sequential scenario is too time-consuming and costly. [Ref. 7:p. 5-14]

The M1 Abrams tank program planned concurrency during EMD in order to meet its aggressive development schedule. DT and OT were conducted simultaneously and both displayed numerous problems. With only eleven prototype vehicles available for test and evaluation and none on-hand at the plant on which to evaluate corrective measures, replicating and solving the problems identified at the test sites became a time-consuming, difficult task. However, both the program office and the contractor were able to surmount this obstacle through great teamwork, ingenuity, diligence, and unity of effort. [Ref.

12:pp. 161&162]

a. Advantages of Concurrency

The advantages of concurrency are:

- Achievement of an earlier operational capability
- Possible reductions in cost for the shorter period
- Design maturity and production start-up problems become visible earlier
- Production articles are usually closer in configuration to test articles [Ref.7:p. 5-16]

b. Disadvantages of Concurrency

The disadvantages of concurrency stem from the inherent risks associated with a complex, technologically advanced system in terms of:

- Performance shortfalls
- Schedule slippage
- Cost growth [Ref. 7:p. 5-16]

3. Design-to-Cost (DTC)

The Acquisition Strategy Guide defines DTC as:

> An acquisition management technique to achieve defense system designs that meet stated cost requirements. Cost is addressed on a continuing basis as part of a system's development and production process. [Ref. 7:p. 5-23]

This cost control mechanism is designed to track contractor costs throughout the design, development, and production of a system in order to identify and highlight any major changes to original estimates. Excessive cost growth in major weapon systems programs can lead to a quick and early project termination. Cost growths occur for a number of reasons,

primarily because of: poor initial cost estimates, cost escalation due to inflation, changes in requirements, and quantity changes. Design and performance trade-offs are often utilized to maintain costs under an established, preset ceiling. [Ref. 7:p. 5-24]

For the M1 tank program, the DTC goal was set at $507,790 per tank (FY 1972 dollars) and this estimate was established as the average unit 'roll-away' cost. [Ref. 12:p. 136] This figure included Government Furnished Material (GFM), contractor manufacturing, and engineering support through production of 3,312 vehicles at a rate of 30 vehicles per month. When the total production figure was increased to 7,058 tanks and the second production facility at Lima, Ohio was brought on-line, the DTC was revised to $611,340 (FY 1972 dollars) but was never formally approved. [Ref. 14:p. B-6]

a. *Advantages of Design-to-Cost*

The advantages of DTC are:

- It defines a <u>measurable</u> design parameter; often considered as important as performance
- It provides a basis for communication and coordination of effort between the Government and industry participants [Ref. 7:p. 5-24]

b. *Disadvantages of Design-to-Cost*

The disadvantages of DTC are:

- It forces the PM to commit to a DTC goal well before final agreement on configuration and operational requirements; thus the need to 'sell' the program may drive the DTC goals down to unrealistic levels
- Additional administrative support is required to plan and execute the DTC program
- Existence of the DTC program could tend to

> inhibit tailoring and innovation
> [Ref. 7:p. 5-24]

4. Pre-Planned Product Improvements (P^3I)

P^3I is an increasingly popular strategy in today's highly technological Defense industry. P^3I enables a PM to:

> ...develop and field a new weapon system while improvements to that system are being planned for phased integration. It is a systematic and orderly acquisition strategy beginning at the system's concept phase to facilitate evolutionary, cost-effective upgrading of a system throughout the life cycle to enhance readiness, availability, and capability. [Ref. 7:p. 5-46]

If technology or the threat changes during system development, the system can either be redesigned (which is extremely costly) or it can be modified after fielding at a later date (affordability issue). P^3I is a planned evolutionary growth which affords the PM a means of incorporating state-of-the-art technology not yet perfected without having to develop an entirely new system. It also provides a mechanism so that multiple, advanced technologies will not have to be incorporated all at once thereby increasing program risk, interface, and reliability deficiencies. [Ref. 7:p. 5-46]

Frequently during design and development, the need for eventual modification is recognized. Hopefully, the need for modification is identified early on and a plan is quickly developed. Such is the case with the M1 tank program.

During prototype validation, debate over the size of the main gun became a sensitive issue. Some wanted the proven American 105 mm main gun and others wanted to incorporate the newly designed German 120 mm main gun. Since there was not an established plan available for a main gun demonstration and evaluation, an alternate plan of action was quickly reached. Both contractors had to design the turret of the tank to be capable of accepting either the 105 mm or the 120 mm main gun.

Although a shoot-off was eventually conducted, the American 105 mm was chosen **not** because it was superior, but because it was proven technology. The recommendation to delay incorporating the German 120 mm main gun until further studies and testing were conducted was made in the fall of 1975 and, thus, a P^3I strategy was adopted. [Ref. 12:pp. 175-177]

As part of P^3I, several improvements were considered for incorporation into the subsequent acquisition plan of the M1A1 tank program. Several improvements were incorporated into the plan in 1984 including a: Improved Commander's Weapon Station, Commander's Independent Thermal Viewer, CO^2 Laser Rangefinder, Driver's Thermal Viewer, fast refuel, and enhanced smoke generation capability. These improvements provide the United States fighting soldier with the most sophisticated, lethal tank on the modern battlefield and all were adeptly incorporated by utilizing the P^3I concept. [Ref. 19:p. 8]

a. *Advantages of Pre-Planned Product Improvements*

The following advantages result from an effective implementation of P^3I:

- Responsiveness to threat changes and future technology development
- Earlier IOC date for baseline system
- Reduced development risks
- Potential for subsystem competition
- Enhanced operational capability for 'final' system
- Stimulation for laboratory and independent R&D research
- Increased effective operational life
  [Ref. 7:p. 5-47]

b. *Disadvantages of Pre-Planned Product Improvements*

The following disadvantages of using P^3I include:

- Increased nonrecurring cost during initial development
- Increased technical requirements in such areas

as space, weight, power, and cooling

- Increased complexity in configuration management
- Vulnerability to 'gold plating' criticism and funding cuts
- Compounding system management problems because of parallel developments
- Interference with the orderly development and implementation of effective support plans and procedures [Ref. 7:p. 5-47]

5. Incentives

Incentivizing a contractor to perform in a realistic, cost-effective, and responsible manner is accomplished through the development and implementation of a contractual strategy. Incentive contracts are utilized to:

> ...motivate the contractor to meet or exceed target levels when there is uncertainty about the outcome and the contractor has some control of the outcome. [Ref. 7:p. 5-29]

Incentive contracts typically reward the contractor for meeting or exceeding defined goals with a monetary remuneration, and, likewise, penalize the contractor for failure to meet these goals. It is a definitive means of encouraging contractors to achieve more than minimum program objectives without excessive risk. [Ref. 7:p. 5-29]

The written contract is the legal basis on which the Government and contractor relationship and responsibilities are definitized and delineated. Two broad categories of contract type exist: cost-reimbursable and fixed-price. Cost-reimbursable contracts are defined as contracts in which the contractor "...provides best efforts to meet the contract terms and conditions and the Government pays all of the allowable costs that meet the test of reasonableness." [Ref. 7:p. 5-29] Fixed-price contracts, on the other hand, require the contractor to "...provide the required product or service

at a predetermined price, regardless of the actual cost." [Ref. 7:p. 5-29]

There are advantages and disadvantages to both types of contracts. Cost-reimbursable contracts are typically utilized when there is high technical risk associated with development and the financial risk is equitably shared by both the contractor and the Government. Because the contractor is paid all allocable and allowable costs, contractors are usually less motivated to control their costs. Conversely, fixed-price contracts are used with lower risk technology and this contract type places more financial responsibility on the contractor to control his costs and, thereby, protect his profit margin. [Ref. 7:pp. 5-29 thru 5-32]

The M1 tank program initially planned on awarding the competitive prototype validation contractors a Fixed-Price-Incentive-Firm (FPIF) contract with incentive on cost only. A FPIF contract was initially selected because: "...from a contractor standpoint, the risk associated with failure is minimal." [Ref. 22:p. 13] The objective of this contract type was to:

- Assure that maximum performance objectives were achieved at minimum cost
- Provide cost visibility desired by the Government during performance
- Allocate equitable Government/contractor share of the associated risk
- Not unduly penalize contractors for failure to meet performance goals [Ref. 22:p. 13]

However, in June of 1973, competitively negotiated Cost-Plus-Incentive-Fee (CPIF) contracts for Phase I were awarded allowing both contractors the largest possible amount of design freedom. The contract had performance-based requirements and the incentive was on cost of contract performance only. [Ref. 16:p. 8]

Winning the DEM/VAL phase, Chrysler Defense was awarded a FPIF contract for EMD which also included the first two years of production. The contractor retained configuration control throughout this period and the PM incorporated a provision for the correction of deficiencies in delivered vehicles due to the concurrency of production and developmental testing. This correction of deficiencies provision was very similar to a warranty against defects. As part of this contract, a competitively-derived ceiling priced option was included with an advance award of 25-30% of the total tank system production cost. This advance award was included to offset long-lead material and production special tooling and test equipment requirements. To offset this risk to the Government, the prime contractor was instructed to obtain competitively-derived ceiling priced options from major sub-component subcontractors. The PM assumed configuration control beginning with the third year of production. Annual contracts for production between 1981 and 1983 were Firm-Fixed Price (FFP). [Ref. 19:pp. 7-15]

a. *Advantages of Incentives*

- Provide greater realism in negotiating
- Increase cost-consciousness
- Encourage Government/contractor cooperation
- Recognize limitations of contractor management and control systems
- Account for motivational variability
- Provide the contractor flexibility in meeting target values [Ref. 7:p. 5-30]

b. *Disadvantages of Incentives*

- The cost and complexity of administration are increased
- It is difficult to establish realistic targets
- There is a tendency to create incentives for too many elements, leading to complex, poorly

understood relationships

- Contract complications arise from Government-directed changes
- The profit motive, the essence of incentive contracting, may not be the prime motive of the contractor [Ref. 7:p. 5-30]

C. SUMMARY

This chapter has highlighted the key strategic decisions made by the initial PM, BG Baer, at the inception of the M1 Abrams tank program. Once made, these decisions had an overwhelming impact on the stability, functionability, and longevity of the program during the ensuing years. This is not to say that once a strategic decision is made it can not be changed. However, to change a 'game plan' after the kick-off often invites outside skepticism and unsolicited program scrutiny and oversight.

Competition, concurrency, design-to-cost, pre-planned product improvements, and incentives are just a few of the multitude of strategic options available to a PM as he plans and charts the course his program will follow. The next chapter analyzes these strategies and highlights some lessons-learned.

V. ANALYSIS AND LESSONS-LEARNED FROM THE M1 ABRAMS ACQUISITION STRATEGY

A. INTRODUCTION

This chapter provides an analysis of the successful acquisition strategy for the M1 Abrams tank program. Previous chapters have presented the historical facts behind the M1 acquisition and its acquisition strategy. To determine why this program's acquisition strategy was notable, the factors that influenced this program's success, as well as the shortcomings that occurred during execution, are analyzed. This analysis is performed utilizing the acquisition strategy evaluation criteria of realism, stability, flexibility, and controlled risk, as established in the Acquisition Strategy Guide. Lessons-learned are identified from these factors which can be practically applied to future major weapon system programs.

B. ANALYSIS OF THE M1 TANK'S ACQUISITION STRATEGY

To label a weapon system program 'successful' solely because the system was eventually fielded is both irresponsible and simple-minded. Although a relative term, success in this analysis is defined as meeting the needs of the user in a cost-effective and timely manner. The M1 Abrams tank program is considered successful because the program achieved its primary goal of satisfying an identified, validated mission need. This program fielded an extremely effective weapon system and it is currently considered by military experts to be the most lethal, survivable tank on the modern battlefield. The M1 tank has met the Army's material and mission needs and it far exceeded its original performance objectives. Although cost and schedule objectives were

narrowly exceeded, the M1's increased performance capabilities and advanced armor protection have offset any shortcomings.

1. Realism

> An acquisition strategy is realistic if the program objectives are attainable and the strategic approach to satisfying them can be successfully implemented with reasonable assurance. [Ref. 7:p. 3-9]

When analyzing this program's acquisition strategy, two questions must be examined:

- Was the proposed system the best solution to the mission need and were the program's cost and schedule estimates realistic?
- Was the program's acquisition strategy and plan a reasonable and realistic means of achieving the Army's identified material need?

To answer both questions, the Army's mission need must be examined in conjunction with the fundamental strategic options incorporated into the acquisition strategy.

At the inception of the M1 program in 1972, the M-60 tank's operational deficiencies were clearly evident and well-documented throughout the armor community. The introduction of the Soviet T-62 and T-64 model tanks in the early and late 1960s stimulated apprehension among United States military analysts. With an improved and larger main gun, lower vehicle silhouette, and a more powerful engine, the T-64 tank was categorized as one more premier and dominant vehicle in the Soviet military arsenal. [Ref. 12:pp.17-21] Because the M-60 tank was already a piece-meal conglomeration of tank technology, the concept of modifying and/or upgrading this system was determined to be an inviable option. The material need for a new and improved tank was not only justified, but amply supported by both the Pentagon and Capitol Hill.

Early establishment of performance-based specifications

with only six mandatory requirements afforded the DEM/VAL contractors the freedom to develop and design a tank within the minimum established performance parameters. This latitude permitted both competitors to conduct trade-off analyses on a variety of tank system features and enabled them to freely incorporate the most promising technological hardware. Negotiating a Cost-Plus-Incentive-Fee (CPIF) contract with a well-established budget limitation provided a reasonable constraint to an otherwise risky development. Once established, this cost ceiling forced both contractors to design and develop their prototype vehicles within a modest budget. Selection of this contract type minimized the addition of unnecessary 'bells and whistles' and unnecessarily expensive 'gold-plating'.

The incorporation of a seven-year development plan was critical in establishing a realistic and reasonable schedule at the onset of the program. In the early 1970's, both military research and development (R&D) laboratories and private industry were experimenting with new armor technology. Solidifying the PM's decision to opt for a seven-year program was the realization that this R&D effort was on the verge of a scientific break-through. Allocating the time necessary to perfect this new technology exhibited great foresight on behalf of the PM. This development schedule was neither overly optimistic nor conservative in nature; it proved to be a wise balance of both.

Throughout the 1970s and 1980s, acquisition strategies incorporated a high degree of concurrency between the development and production phases. The M1 program was no exception to this norm. Although the aforementioned seven-year plan allowed adequate time for technological ingenuity, it was, nonetheless, a time-table established without much room for error. Concurrency of developmental and operational testing (DT/OT) was predicated on sound reasoning, namely to

reduce the time necessary to begin Low-Rate Initial Production (LRIP). Initial problems with engine and transmission failures, thrown tank track, and inadequate operator and maintenance manuals were eventually rectified with little impact on the schedule. Although a major source of concern at the time, the insufficient number of prototype vehicles available for testing proved to be just one of many obstacles the PM/contractor team successfully surmounted. Overall, concurrency proved very effective and was instrumental in maintaining the program's aggressive developmental schedule.

One noteworthy weakness impacting strategic realism resulted from underestimated design-to-cost (DTC) appraisals. Because justification for program funding was very competitive and Congress had previously stated they would not accept a million dollar tank, the PM and other program advocates were predisposed to 'sell' their program with a less than realistic cost estimate. Lacking the cost estimation techniques and trained personnel available today, the proposed $507,790 (FY 1972 dollars) sticker price per tank was somewhat undervalued. The program did remarkably well, however, in keeping costs under control and remained fairly close to the original estimate. Unfortunately, two unforeseen events precipitated the increased cost per tank:

- An unanticipated, larger than normal rise in the inflation rate between 1974 and 1982.
- The incorporation of the 120mm main gun upgrade coupled with the decision to more than double the number of tanks to be produced (from 3,312 to 7,058).

Changes late in any program normally have a detrimental impact, particularly on cost and schedule. In defense of the PM, none of the above mentioned factors could have been anticipated. In fact:

> In 1988, a decade and a half after the rather artificial design-to-unit-cost goal was set at $507,790, the Army claimed that the individual tank,... was coming in at just a little over that price - in 1972 dollars. [Ref. 12:p. 250]

In retrospect, it is clear that development of the M1 Abrams tank was the best solution to the identified mission need. Cost and schedule estimates were both reasonable and realistic. This program's acquisition strategy, as developed and implemented, provides a positive example of realism in today's DoD acquisition and procurement environment.

2. Stability

> Acquisition stability is the characteristic that inhibits negative external or internal influences from seriously disrupting program progress, which...frequently causes changes in cost, schedule, or performance requirements that can threaten the achievement of milestones. [Ref. 7:p. 3-13]

From program inception through the late 1980's this tank program has been a model of stability. This, however, is not to say it never encountered problems. Three critical factors provided a stable, steady program platform; without any one of which, the success of the program would have suffered. These critical factors were:

- High-level advocacy and commitment throughout the Army, the Pentagon, and from Capitol Hill.
- A coupling of PM stability and longevity with a unity of effort philosophy throughout the chain of command.
- Critical mid-stream changes were handled with extreme efficiency and, when necessary, were incorporated into a Pre-Planned Product Improvement (P^3I) program.

a. *Program Advocacy*

Rebuilding a hollow, somewhat obsolescent Army at the conclusion of the Vietnam War in the early 1970's became a top priority inside the Pentagon. Realization that the expense of the war had resulted in a complete failure to maintain an edge in research and development efforts as well as procurement of modernized, state-of-the-art equipment, forced top leadership officials to prioritize new weapon system programs. At least nine major new weapon systems were vying with one another for a big slice of the Army's shrinking budget. [Ref. 12:p. 87] The highest priority went toward the development of a new tank and this early prioritization forced the Army to speak with one voice. This up-front, unified commitment within the Army was critical in fostering the support necessary from Congress and special interest groups and enhancing program advocacy at its highest level. Understanding the fine-line limitations of this Congressional support, i.e. the economical, technological, and societal implications, was key in harboring and maintaining unified commitment. The M1 Abrams tank program evidently maintained this support and this factor alone, contributed greatly to its overall success.

b. *PM Stability*

One way to enhance stability inside an organization is by establishing and maintaining a coherent, well-balanced management structure. When Chief of Staff of the Army, General Abrams, appointed BG Baer as the initial PM for the program, the first thing he did was give Baer a seven-page charter with a direct channel of communication to both himself and the Secretary of the Army. Incorporating the top representative of the user community, MG Starry, Commandant of the Armor Center, into the fold of this management hierarchy solidified the cooperation and viability between the input of the user community and the PM's acquisition strategy for

accomplishing the production of a world-class tank. The close personal and working relationship between BG Baer, MG Starry, and General Abrams, was another key to the early success of this program.

Each PM served a minimum of three years as the head of the program, with BG Baer serving five years at the helm at program inception. This low turn-over rate of principal management, was extremely important and laid a firm foundation from the program's start. Changes in organization and personnel can cause major disruptions and undermine continuity. This pitfall was consciously avoided with orderly, well-timed, PM changes that coincided with major milestone decision points. Continuity and stability were maximized to every extent possible within the program office.

c. Managing Change

Two major changes incorporated during the program were: the main gun upgrade from the 105mm to the 120mm and the quantity of tanks to be produced. Although ominous in nature and potentially devastating to any program, both changes were carefully analyzed and thoroughly planned.

Recognizing the overall impact of the hotly debated, sensitive issue of main gun size early during prototype validation afforded both the PM and the contractors the opportunity to develop and incorporate a turret design which was capable of handling either size main gun. This early anticipation of future product modification was critical to the implementation of a P^3I strategy. Further study and testing was necessary on the immature technology of the 120mm main gun and this realization helped to delay its incorporation for several years; a very prudent and wise decision on behalf of the entire program's leadership. This planned evolutionary growth implemented through the use of the P^3I strategy, afforded the PM a means of incorporating technology not yet perfected without having to develop an

entirely new system. As previously mentioned, the 120mm main gun upgrade was incorporated into the M1A1 Abrams Tank in 1985.

The decision to more than double the number of tanks to be produced from 3,312 to 7,058, although not affecting design, still had repercussions on the program. Once again, the early timing of such a drastic change offset what could have been an adverse, overly-expensive decision to implement. Recommendations to increase production quantities first surfaced in 1977, two years before LRIP commenced. [Ref. 14:p. B-6] Because planning commenced early, adequate time was available to procure long-lead items. In addition, the establishment of a second fully-operational, modern production facility in Lima, Ohio provided the necessary production capacity required to handle this quantity increase.

3. Flexibility

> Flexibility is a characteristic of the acquisition strategy related to the ease with which changes and failures can be accommodated without significant changes in resource requirements. [Ref. 7:p. 3-17]

Flexibility in a strategic context involves contingency planning or 'what if?' war-gaming. Providing a back-up or alternative method of meeting an objective is one of the best means available to cope with change. [Ref. 7:p. 3-17] Time available is one of the most important elements when dealing with change and uncertainty and this consideration was factored into the M1 program from the very beginning when a seven-year development plan was implemented. The addition of one year to the program provided a safe measure of flexibility and ample buffer space to manage unexpected change.

Several of the implemented acquisition strategies either addressed or accounted for program flexibility. The use of performance specifications allowed great freedom to both contractors to design a system within the minimum parameters

required during prototype validation. The eventual negotiation of a CPIF contract for EMD provided flexibility to both the contractor and the PM. This contract type allowed the contractor to retain latitude and flexibility in meeting pre-set target levels, while simultaneously providing the Government with flexible incentive options if any changes were required.

Additional flexibility was incorporated through the use of concurrency during DT/OT. The use of LRIP also provided a large degree of flexibility by allowing the manufacturing and production process to be continually refined at a lower cost while deficiencies were corrected. Utilizing both "break-out" during follow-on production and second-sourcing also added flexibility by providing an alternative source of supply in the event that one failed to meet its requirements.

Several safeguards were incorporated into the M1 Abrams acquisition strategy. Identifying and planning early for those areas displaying the highest probability of change was clearly evident and proved to be another critical factor in the success of this program.

4. Controlled Risk

> Risk, as applied to acquisition strategy, is a measure of the probability and consequence of not achieving a defined program goal. [Ref. 7:p. 3-20]

Dealing with inherent risk and uncertainty is the fundamental management challenge that all PMs face. Charting a successful program course through system production and fielding involves identification, assessment, and planning for the unknown. Risk mitigation is the underlying purpose behind the development and implementation of an acquisition strategy.

The M1 tank program was clearly successful in identifying, analyzing, and minimizing risk throughout program execution. The three key elements of the M1 acquisition

strategy which minimized risky alternatives were:

- Combining a seven-year development plan with P^3I.
- Fly-Before-Buy prototype validation.
- Early and continuous interaction between the program office and the end-user community.

a. Seven-Year Development Plan and P^3I

The M1 tank program minimized technical risk by allocating the time necessary to fully develop, test, and integrate its new armor technology. Because this new armor technology would heavily impact weight constraints and virtually every other design facet of the tank, providing the time necessary to perfect this technology was critical to achieving the cost, schedule, and performance parameters of the entire program. In addition, the P^3I concept provided a means of incorporating late design improvements and performance enhancements to the tank in an orderly, systematic, pre-planned manner without affecting schedule. Risk was addressed and minimized by the proper allocation of a critical resource: time.

b. Fly-Before-Buy Prototype Validation

Combining performance-based specifications with competitive prototype validation during DEM/VAL enabled the Army to choose the best tank design that fit its need. Performance specifications allowed both contractors the freedom to explore solutions and to demonstrate technology in a competitive environment under Army direction. The program office, through a Fly-Before-Buy prototype demonstration, was able to assess and evaluate each system's configuration, design, and performance capability, and award a contract to the one who best fulfilled its need.

Allowing both contractors to demonstrate their technological solutions in the form of fully-operational, functional prototypes clearly reduced program risk. Evaluation of each proposed design through actual hands-on

manipulation is inherently less risky than a computer-generated model or blue-print design analysis. In addition, because the Army funded the Fly-Before-Buy prototype research and validation, it was free to incorporate all the good points from the unsuccessful competitor into the winning design.

c. Continuous Interaction Between the Program Office and the End-User Community

Because the PM depends on the user for continuous input to many of the required documents for milestone decision reviews, program success can not be achieved without close and continuous user participation. [Ref. 24:p. 31.19] Obviously, the end-user is involved in the requirements generation process of a major weapon system. However, the role the user plays in the total acquisition process to include: design, development, test and evaluation, deployment, and logistical support, is essential. This user influence, however, must be carefully balanced by the PM in terms of overall program objectives. One way to reduce program risk and uncertainty is to maintain continuous interaction and feedback between the program office and the demands of the user. Serious problems may arise when the user does not understand the impact of changes in requirements to the three critical areas of cost, schedule, and performance.

The M1 tank program maintained excellent communications between the PM and the armor community. Clearly, this program incorporated user involvement early in the acquisition process and maintained this very important role throughout the entire management process.

C. LESSONS-LEARNED

The intended purpose of lessons-learned:

> ...is to provide a means to systematically access, scrutinize, and choose from past experiences those lessons we can apply in a new situation with a high probability that their use will result in a better

course of action and results than would have been expected without their use. [Ref. 24:p. 44.2]

Six important lessons are derived from this case study.

- Use of performance-based specifications with well-established minimum requirements allows competing contractors the freedom to explore solutions and to conduct trade-off analysis on a variety of system features. Performance-based specifications enable contractors to freely incorporate the most promising technological hardware during the development and design process.
- Fostering program advocacy at the highest level from program inception is critical in the current era of shrinking Defense expenditures. Congressional support is paramount to program funding and, thus, program survival.
- Maintaining continuity of key personnel, especially the Program Manager, is critical in establishing a firm management foundation. Without management continuity, program stability can be seriously undermined.
- Well-written, understandable maintenance and operation manuals published by the contractor will prove invaluable during DT/OT. Responsibility for written technical manuals must be delineated early-on in the program.
- Continuous interface between the program office and the end-user community is critical throughout the entire acquisition process. User participation begins with requirements generation and continuously evolves through logistical support.
- A sufficient number of DT/OT prototype vehicles must be manufactured to allow for timely diagnosis and correction of deficiencies at both the test

site(s) and the production facility. Limiting or cutting the number of available prototypes may save a few dollars in the short run, but invariably has a much higher cost (in terms of maintaining a tight schedule) in the long run.

D. SUMMARY

This chapter has analyzed and highlighted several key reasons why the M1 Abrams tank program has enjoyed overwelming success. Development of an acquisition strategy that addresses the fundamental issues of realism, stability, flexibility, and controlled risk is no easy task. The PM, in continuous interaction with the user community, is responsible for the development and execution of the acquisition strategy.

This program was successful because it: maintained program advocacy, developed a realistic and achievable schedule, allowed the contractor the freedom to design within specific performance parameters and, perhaps most importantly, produced the most lethal, survivable, and technologically advanced main battle tank in the world.

VI. CONCLUSIONS

A. GENERAL CONCLUSIONS

It is clear that the formulation of a sound program acquisition strategy is a difficult and arduous task. The Program Manager (PM) plays an intricate and vital role in formulating the direction and path the program will follow throughout its life-cycle. In an effort to provide acquisition managers and the Department of Defense (DoD) with successful lessons-learned, this thesis has examined one of the premier programs of the 1970s and early 1980s: the M1 Abrams tank.

At a time when Defense dollars and resources are waning, both successful and unsuccessful programs must be closely examined. This analysis of the M1 Abrams acquisition strategy has provided numerous examples of a well-managed and well-supported program environment. This program began with a clearly defined Mission Need Statement. It received and maintained critical DoD and Congressional support and had an exceptional cast of program leadership. The contractor was given the freedom to design and develop a weapon system within minimum stated parameters that met or exceeded all user requirements and performance objectives. A well-developed schedule allocating the time necessary to develop immature technology was implemented and followed with little deviation. Pre-Planned Product Improvements (P^3I) were well-thought out and adeptly incorporated into follow-on models. In summary, this program epitomizes the way an acquisition strategy should be formulated and executed.

B. ANSWERS TO RESEARCH QUESTIONS

- **What were the principal successes and failures experienced with the acquisition strategy of the M1 Abrams Tank System and can they be duplicated or**

avoided in future major weapon systems acquisitions?

The acquisition strategy for this program was unique from its inception. The procurement philosophy for the M1 program was based on a seven-year development concept. The most significant benefit of the seven-year development program over the six-year period, was a drastic reduction in the degree of technical risk associated with achieving the required levels of armor protection within the weight limits imposed.

The M1 Abrams tank program utilized competition during its Demonstration and Validation (DEM/VAL) Phase although qualified competitors in this exclusive market were, obviously, limited. In addition to the aforementioned competitive strategy, "break-out" was also included as an option during full-scale production. Sole-source procurement proved to be the most beneficial to the Government in terms of cost and readiness and was utilized during Engineering and Manufacturing Development (EMD), Low-Rate Initial Production (LRIP), and full-scale production.

Concurrency of developmental and operational testing (DT/OT) was utilized during EMD in order to meet an aggressive development schedule. DT and OT were conducted simultaneously and both encountered numerous problems. The quantity of prototype vehicles available for DT/OT was insufficient and inadequate for correcting deficiencies found at both test sites and the production facility. However, both the program office and the contractor were able to surmount the many obstacles encountered through great teamwork and unity of effort.

A Design-to-Cost (DTC) goal was set at $507,790 per tank (FY 1972 dollars) and this estimate was established as the average unit 'roll-away' cost. This cost control mechanism is designed to track contractor costs throughout the design, development, and production of a system in order to identify

and highlight any major changes to original estimates. The program was successful in coming in just a little above that price.

A Pre-Planned Product Improvement (P^3I) strategy was incorporated which afforded the PM a means of incorporating not yet perfected technology without having to develop an entirely new system. This proved to be a very successful concept and it minimized late design changes that could have seriously undermined the stability of the program.

Incentivizing a contractor to perform in a realistic, cost-effective and responsible manner was accomplished through the development and implementation of various contractual strategies. Competitively negotiated, Cost-Plus-Incentive-Fee (CPIF) contracts for DEM/VAL were awarded allowing both contractors the largest possible amount of design freedom. The contract had performance-based requirements and the incentive was on cost of contract performance only. Winning the DEM/VAL phase, Chrysler Defense was awarded a Fixed-Price-Incentive-Firm (FPIF) contract for EMD which also included the first two years of production. Annual contracts for production between 1981 and 1983 were Firm-Fixed-Price (FFP).

Overall, this program's acquisition strategy was well planned and executed and provides an excellent example of an effective, functional acquisition environment. There is no reason that these strategic concepts cannot be successfully incorporated into future programs remembering that each program should be tailored and continuously refined as it progresses.

- **What is a Mission Need Statement and what is involved in its development?**

The Mission Need Statement (MNS) defines a Service's perceived mission need in broad operational terms, identifies

the validated threat to be countered as well as the projected threat environment in which it needs to operate, and outlines the initial acquisition strategy the proposed system will follow.

Mission Area Analysis is conducted to identify any deficiencies in existing defense capabilities. If a serious deficiency exists and it can not be countered by a change in doctrine, tactics, or other non-material solutions, it is documented in a MNS, validated, and once approved, enters into the Concept Exploration/ Definition Phase for further research and study.

- **What was the Mission Need Statement for the M1 Abrams Tank System?**

Succinctly stated, the Mission Need Statement for the M1 Abrams tank was to field a tank system specifically designed as an assault vehicle to replace an aging fleet and to meet the projected threat of the 1980's and beyond. In addition, this tank system would provide increased performance over other tanks currently in the Army inventory in the areas of reliability, availability, maintainability, survivability, tactical mobility, night fighting capability, and hit probability.

- **What is an Acquisition Strategy and how does it relate to the overall acquisition process?**

An acquisition strategy can be thought of as the primary road map or blueprint on how the PM expects to evolve from the basic mission need to system production and equipment fielding. It is a 'living' document which is updated and revised from its inception during Phase 0 throughout the entire acquisition process.

It covers the entire life-cycle of the proposed system and is one of the tools utilized to reduce and mitigate risks

in the program. This strategy lays the foundation for management concepts, control measures, contracting alternatives, competition, test and evaluation requirements, logistics support, personnel and training requirements, funding issues, and a host of other important factors in the acquisition program.

- **What DoD directives and policies govern the formulation of an Acquisition Strategy?**

There are a number of program planning documents which require the development of an acquisition strategy. Because of its importance, the strategy will be tailored to meet the specific needs of the program as directed by DoD Directive 5000.2 The Federal Acquisition Regulation (FAR) and other directives issued by DoD and each individual Service also govern strategy formulation.

- **What was the overall Acquisition Strategy for the M1?**

The M1 acquisition strategy utilized a seven-year development concept in conjunction with a DTC threshold. CPIF contracts were awarded during the Fly-Before-Buy competitive prototype validation. Performance-based specifications were utilized during the competition and a sole-source contractor was selected for EMD. This contractor was awarded a FPIF contract that included the first two years of production only. LRIP and concurrent DT/OT were utilized during EMD. Although competition was planned for full-scale production, a sole-source justification based on cost and schedule constraints was utilized. P^3I was also incorporated into the acquisition strategy along with component break-out during follow-on production.

- **What is an Acquisition Plan? What are the basic requirements involved in its development and approval?**

Acquisition planning is the process by which the efforts of all personnel responsible for an acquisition are coordinated and integrated through a comprehensive plan for fulfilling the agency need in a timely manner and at a reasonable cost.

The acquisition plan has statutory and regulatory requirements outlined in the FAR, Part 7. This plan documents the decisions made during the development of the acquisition strategy to include: the program's major objectives, policies, and all the definitive actions that must be accomplished during the various phases of the acquisition cycle. It integrates all of the technical, business, management, legal, and other significant actions which must be accomplished throughout the life-cycle of the program. It is approved by the Milestone Decision Authority (MDA).

- **What was the overall Acquisition Plan (including Milestones) for this program and to what extent did execution of the program meet the plan?**

The procurement philosophy for the tank was a seven-year development program accomplished in three separate, distinct phases. Phase I of the plan was Competitive Prototype Validation, currently known as DEM/VAL. This phase combined both the Concept Exploration and Definition phase and the Demonstration and Validation phase of today into one succinct phase of operation.

Phase II of the plan was Engineering Development and Producibility Engineering and Planning (ED/PEP), known today as EMD. Phase III was LRIP with follow-on full-scale production.

The program followed its initial acquisition plan and was extremely successful. The newly-designed and developed M1 tank met or exceeded all the design and performance

specifications required by the Army.

APPENDIX A: ACRONYMS AND DEFINITIONS

The following acronyms and definitions are synopsized from the Defense Systems Management College manual, Glossary: Defense Acquisition Acronyms & Terms.

ACAT - Acquisition Category. Categories established to facilitate decentralized decision-making and execution and compliance with statutorily imposed requirements. The categories determine the level of review, decision authority, and applicable procedures.

Acquisition Plan - A formal written document reflecting the specific actions necessary to execute the approach established in the approved acquisition strategy and guiding contractual implementation.

Acquisition Strategy - A business and technical management approach designed to achieve program objectives within resource constraints imposed. It is the framework for planning, directing, and managing a program. It provides a master schedule for research, development, test, production, fielding, and other activities essential for program success, and for formulating functional plans, and strategies to include: Test and Evaluation Master Plan, Acquisition Plan, competion, prototyping, etc.

ADM - Acquisition Decision Memorandum. A memorandum signed by the milestone decision authority that documents decisions made and the exit criteria established as the result of a milestone decision review or in-process review.

APB - Acquisition Program Baseline. Acquisition program baselines embody the cost, schedule, and performance

objectives of the program. It is approved by the milestone decision authority at milestone reviews.

ASARC - Army Systems Acquisition Review Council. The Army-level equivalent to the Defense Acquisition Board. Chaired by the Army Acquisition Executive, it provides recommendations and input prior to each Milestone review.

Break-Out. Execution of acquisition strategy to convert some parts or system components from contractor-furnished to government-furnished. Rather than having prime contractor provide from its sources, government goes out to industry directly and procures items.

CAE - Component Acquisition Executive. A single official within a Department of Defense Component who is responsible for all Acquisition functions within that component. This includes Service Acquisition Executives for the Military Departments and Acquisition Executives in other DoD Components who have acquisition management responsibilities.

CE/D - Concept Exploration and Definition. Beginning at Mission Need Determination, the initial phase of the system acquisition process. During this phase, the acquisition strategy is developed, system alternatives are proposed and examined, and the systems program requirements document is expanded to support subsequent phases.

CICA - Competition in Contracting Act. Passed in 1984, this Act contains numerous provisions dealing with the enhancement of competition and the restriction of noncompetitive procurement procedures.

COEA - Cost and Operational Effectiveness Analysis. An analysis of the costs and operational effectiveness of alternative material systems to meet a mission need and the associated program for acquiring each alternative.

Concurrency. Part of an acquisition strategy which combines or overlaps phases of the acquisition process, or development T&E and operational T&E.

Contractor. An entity in private industry which enters into contracts with the government to provide goods or services.

DAB - Defense Acquisition Board. The senior Department of Defense acquisition review board chaired by the Under Secretary of Defense for Acquisition and Technology (USD(A&T)). The Vice Chairman of the Joint Chiefs of Staff is the Vice-Chair. Other members include the Deputy USD(A&T); Acquisition Executives of the Army, Navy, and Air Force; the Director of Defense Research and Engineering; the Assistant Secretary of Defense for Program Analysis and Evaluation; and the Comptroller of the Department of Defense.

DAE - Defense Acquisition Executive. The principal advisor and assistant to the Secretary of Defense and the focal point in OSD for the systems acquisition process. The USD(A&T) is the DAE.

DATP - Detroit Arsenal Tank Plant.

DEM/VAL - Demonstration and Validation. Normally the second phase in the acquisition process, following Milestone I.

Consists of steps necessary to resolve or minimize logistics problems identified during concept exploration, verify preliminary design and engineering, build prototypes, accomplish necessary planning and fully analyze trade-off proposals. The objective is to validate the choice of alternatives and to provide the basis for determining whether to proceed into Engineering & Manufacturing Development.

DoD - Department of Defense.

DSARC - Defense Systems Acquisition Review Council. (obsolete) Currently replaced by the Defense Acquisition Board.

DT - Developmental Test and Evaluation. Test and evaluation conducted to measure progress, usually of component/sub-systems, and to assist the engineer design and development process and verify attainment of technical performance specifications and objectives. Usually conducted under controlled or laboratory conditions.

DTUC - Design-to-Unit-Cost. Management concept wherein rigorous cost goals are established during development and the control of systems costs (acquisition, operating, and support) to these goals is achieved by practical tradeoffs between operational capability, performance, costs, and schedule. Cost, as a key design parameter, is addressed on a continuing basis and as an inherent part of the development and production process.

ED/PEP - Engineering Development and Producibility Engineering and Planning. (obsolete) Currently known as Engineering and Manufacturing Development (EMD).

EMD - Engineering and Manufacturing Development. The third phase in the acquisition process, following Milestone II. The system/equipment and the principal items necessary for its support are fully developed, engineered, designed, fabricated, tested, and evaluated. The intended output is, as a minimum, a pre-production system which closely approximates the final product, the documentation necessary to enter the production phase, and the test results which demonstrate that the production product will meet stated requirements.

FAR - Federal Acquisition Regulation. A published Federal Government regulation guide which details all requirements for acquisition and procurement inside all Federal Government agencies.

FMS - Foreign Miliary Sales. That portion of U.S. security assistance authorized by the Foreign Assistance Act of 1961, as amended, and the Arms Export Control Act, as amended. The recipient provides reimbursement for defense articles and services transferred from the U.S.

FOC - Full Operational Capability. The full attainment of the capability to employ effectively a weapon, item of equipment, or system of approved specific characteristics, which is manned and operated by a trained, equipped, and supported military unit or force.

FOT&E - Follow-On Operational Test and Evaluation. That test and evaluation that is necessary during and after the production period to refine the estimates made during operational test and evaluation, to evaluate changes, and to reevaluate the system to ensure that it continues to meet

operational needs and retains its effectiveness in a new environment or against a new threat.

FY - Fiscal Year. U.S. Government calendar year from 1 October to 30 September (12 months).

FYDP - Future Years Defense Program. The official DoD document which summarizes forces and resources associated with programs approved by the Secretary of Defense. Its three parts are the organizations affected, appropriations accounts (RDT&E, operations & maintenence, etc.) and the 11 major force programs (strategic forces, airlift/sealift, R&D, etc.) Under the biennial PPBS cycle, FYDP is updated in even years in April (POM); October (budget); and then in January (President's budget) of odd years.

GDLS - General Dynamics Land Systems.

GFE - Government Furnished Equipment. Property in the possession of or acquired directly by the Government, and subsequently delivered to or otherwise made available to the contractor.

GFM - Government Furnished Material. Material is Government property which may be incorporated into or attached to an end item to be delivered under a contract or which may be consumed in the performance of a contract. It includes, but is not limited to, raw and processed material, parts, components, assemblies, and small tools and supplies.

GOCO - Government-Owned-Contractor-Operated. A manufacturing plant that is owned by the Government and operated by a

contractual civilian organization.

Gold Plating. A term used to denote excessive or additional materials, components, or gadgetry that have an associated cost burden to the Government but provide no added benefit or intrinsic value to a given system.

IOC - Initial Operational Capability. The first attainment of the minimum capability to effectively employ a weapon, item of equipment, or system of approved specific characteristics, and which is manned and operated by an adequately trained, equipped, and supported military unit or force.

IOT&E - Initial Operational Test and Evaluation. All operational test and evaluation conducted on production or production representative articles, to support the decision to proceed beyond low-rate-initial-production. It is conducted to provide a valid estimate of expected system operational effectiveness and operational suitability.

JROC - Joint Requirements Oversight Council. A council, chaired by the Vice Chairman, Joint Chiefs of Staff, that: conducts requirements analyses; determines the validity of mission needs and develops recommended joint priorities for those needs it approves; and validates performance objectives and thresholds in support of the Defense Acquisition Board. Council members include the Vice Chiefs of the Army, Navy, and Air Force, and the Assistant Commandant of the Marine Corps.

LATP - Lima Army Tank Plant.

LCC- Life Cycle Cost. The total cost to the Government of

acquisition and ownership of a system over its useful life. It includes the cost of development, acquisition, support, and, where applicable, disposal.

LRIP - Low-Rate-Initial-Production. The production of a system in limited quantity to provide articles for operational test and evaluation, to establish an initial production base, and to permit an orderly increase in the production rate sufficient to lead to full-rate production upon successful completion of operational testing.

MAA - Mission Area Analysis. The process by which warfighting deficiencies are determined, technological opportunities for increased system effectiveness and/or cost reduction are assessed, and mission needs identified.

MBT - Main Battle Tank.

MDA - Milestone Decision Authority. The individual designated to make decisions resulting from milestone reviews of defense acquisition programs. Acquisition category (ACAT) levels determine the level of milestone decision authority. The MDA for ACAT ID programs is the Under Secretary of Defense for Acquisition and Technology (USD(A&T)).

MNS - Mission Need Statement. A non-system specific statement of operational capability need, developed by DoD Components and forwarded to the Joint Requirements Oversight Council (JROC) for validation and approval (major efforts), or to the JROC for information (non-major efforts). The MNS goes to the milestone decision authority for a determination on whether or not to convene a Milestone 0 review.

MOU - Memorandum of Understanding. Official agreements concluded between the defense ministries of NATO nations and ranking below government-level international treaties. Defacto, such agreements are generally recognized by all partners as binding even if no legal claim could be based on the rights and obligations laid down in them.

NBC - Nuclear, Biological, and Chemical.

OMB - Office of Management and Budget. Federal Government agency which establishes executive policy. OMB Circular A-109 establishes executive policy for the acquisition of major systems and applies to all executive branch agencies.

ORD - Operational Requirements Document. Previously known as the Required Operational Capability (ROC). Documents the user's objectives and minimum acceptable requirements for operational performance of a proposed concept or system.

O&S Cost - Operating and Support Cost. Those resources required to operate and support a system, subsystem, or a major component during its useful life in the operational inventory.

OT - Operational Test and Evaluation. A field test, under realistic conditions, of any item (or key component) of weapons, equipment, or munitions for the purpose of determining the effectiveness and suitability of the weapons, equipment, or munitions for use in combat by typical military users; and the evaluation of the results of such tests.

PM - Program Manager. Official responsible for managing a

specific acquisition program who reports to and receives direction from either a Program Executive Officer or a Component Acquisition Executive.

PPBS - Planning, Programming, and Budgeting System. The primary resource allocation process of DoD. One of three major decision-making support systems for defense acquisition. It is a formal, systematic structure for making decisions on policy, strategy, and the development of forces and capabilities to accomplish anticipated missions. PPBS is a cyclic process containing three distinct, but interrelated phases: planning, which produces Defense Planning Guidance (DPG); programming, which produces an approved Program Objectives Memorandum (POM) for the Military Departments and Defense Agencies; and budgeting, which produces the DoD portion of the President's national budget.

P^3I - Pre-Planned Product Improvement. Planned future evolutionary improvement of developmental systems for which designed considerations are effected during development to enhance future application of projected technology. Includes improvements planned for ongoing systems that go beyond the current performance envelope to achieve a needed operational capability.

RAM-D - Reliability, Availability, Maintainability, and Durability. Requirement imposed on acquisition systems to ensure they are operationally ready for use when needed, will successfully perform assigned functions, and can be economically operated and maintained within the scope of logistics concepts and policies.

R&D - Research and Development. Activities for the development of a new system that include basic and exploratory research, and advanced and engineering development.

RDT&E - Research, Development, Test and Evaluation. Activities for the development of a new system that include basic and exploratory research, advanced and engineering development, development and operational testing and the evaluation of test results.

RFP - Request For Proposals. A solicitation used in a negotiated acquisition to communicate Government requirements to prospective contractor(s) and to solicit proposals.

ROC - Required Operational Capability. (obsolete) Currently known as the Operational Requirements Document (ORD). Details the performance and related operational parameters for a concept or system proposed for meeting the Mission Need Statement (MNS).

SECDEF - Secretary of Defense.

SSA - Source Selection Authority. The official designated to direct the source selection process, approve the source selection plan, select the source(s), and announce contract award.

TDP - Technical Data Package. A technical description of an item adequate for supporting an acquisition strategy, production, engineering, and logistics support. The description defines the required design configuration and procedures to ensure adequacy of item performance. It

consists of all applicable technical data such as drawings, associated lists, specifications, standards, performance requirements, quality assurance provisions, and packaging details.

USD(A&T) - Under Secretary of Defense for Acquisition and Technology. The USD(A&T) has policy and procedural authority for the defense acquisition system and is the principal acquisition official of the Department and is the acquisition advisor to the Secretary of Defense. In this capacity the USD(A&T) serves as the Defense Acquisition Executive (DAE), the Defense Procurement Executive, and the National Armaments Director; the last regarding matters of the North Atlantic Treaty Organization (NATO). His authority ranges from directing the Services and Defense Agencies on acquisition matters, to establishing the Defense Supplement to the Federal Acquisition Regulation (FAR), and chairing the Defense Acquisition Board (DAB) for major defense acquisition program reviews.

User - That command, unit, or element which will be the recipient of the production item for use in accomplishing a designated mission. This term is also used to define the operator and maintainer of the system.

APPENDIX B: M1 ABRAMS TANK SYSTEM CHARACTERISTICS (UNCLASSIFIED)

PHYSICAL CHARACTERISTICS

Weight, combat loaded............58.9 tons
Ground Clearance....................19 in
Height, turret roof...............93.5 in
Length, main gun forward.........384.5 in
Length, main gun rearward........353.2 in
Width............................143.8 in

PERFORMANCE CHARACTERISTICS

Acceleration, 0 to 20 mph..........6.1 sec
Maximum forward speed, governed.....45 mph
Average cross country speed.........30 mph
Range, constant speed 25 mph.....275 miles
Fording depth
without kit...................48 in
with kit................Turret roof
Obstacle Crossing
Vertical wall..................49 in
Trench..........................9 ft
Braking
30 mph speed, dry/level....14 ft/sec^2
Ground pressure..................13.3 psi

SUSPENSION

Type......................Hydromechanical
Road wheels....................7 per side
Torsion bars...................7 per side
Shock absorbers, modular rotary.3 per side
Track.........................Integral or
replaceable pad

ELECTRICAL SYSTEM

Electrical power
6 batteries, 12 volts......24 v.d.c.
Electrical capacity
battery only...........300 amp hours
Alternator, charging system........650 amp
Voltage regulator.............solid state

FIRE CONTROL

Rangefinder, laser........200-8,000 meters
Night vision................Thermal Imager
Gunner's sight....................1,3,&10X
Commander's MG sight...................3X

ARMAMENT

Main Gun.................105mm
Coaxial machinegun(MG)..7.62mm
Commander's MG..........50 cal
Loader's MG.............7.62mm
Smoke grenade launcher....40mm
Rifle...................5.56mm

AMMUNITION STOWAGE

Main Gun................55 rds
Coaxial MG..........10,000 rds
Commander's MG.......1,000 rds
Loader's MG..........1,400 rds
Smoke grenades..........24 rds
Rifle..................210 rds

TRANSMISSION

Type......Automatic/Mechanical
Ranges...............4 forward
2 reverse
Steering..........Hydrostatic
T-bar control
Braking..........Hydraulic and
mechanical

ENGINE

Type.........1500 HP Multifuel
Turbine, Air Cooled
Gross HP..1,500 HP @ 3,000 rpm
Gross torque
2,620 lb/ft @ 3,000 rpm
Max torque
3,952 lb/ft @ 1,500 rpm
Fuel capacity.........508 gals
Oil capacity
including oil cooler and
line capacity.....7 gals

OTHER EQUIPMENT

Driver passive night vision
device
Halon Electro-optical Fire
Suppression System

FIRE CONTROL

Auxiliary Telescope....................8X
Gun/Turret drive.........Electro-hydraulic
Gunner or Commander can fire main weapon system
Ballistic computer..Digital, self checking

OTHER EQUIPMENT

Crew heater
NBC protection filter system
Bilge pump
Radio/Intercom communication system

[Ref. 20:pp. 33-34]

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